

SIGNIFICANCE OF WATER QUALITY TO FISH PROPAGATION, WATERFOWL  
HABITAT, LIVESTOCK WATERING, AND RECREATION USE FOR 24 LAKES AND  
RESERVOIRS IN VALLEY AND PHILLIPS COUNTIES, MONTANA

By Rodger F. Ferreira

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## CONVERSION TABLE

The following factors can be used to convert from the International System of units (SI) in this report to the equivalent inch-pound units.

| <u>Multiply SI unit</u>                               | <u>By</u> | <u>To obtain inch-pound unit</u>          |
|---|-----------|---|
| hectare (ha)  | 2.471     | acre                                      |
| kilometer   | 0.6214    | mile                                      |
| meter (m)   | 3.281     | foot                                      |
| microsiemens per centimeter<br>at 25° Celsius (μS/cm) | 1.000     | micromho per centimeter at<br>25° Celsius |
| milliliter (mL)                                       | 0.0338    | ounce (fluid)                             |
| millimeter (mm)                                       | 0.0394    | inch                                      |
| square meter (m <sup>2</sup> )                        | 10.76     | square foot                               |

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by the formula:

$$^{\circ}\text{F} = 1.8^{\circ}\text{C} + 32$$

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ABSTRACT

Twenty-four reservoirs in Valley and Phillips Counties, Montana, were sampled for water quality to determine their suitability for fish propagation, waterfowl habitat, livestock watering, and recreation use. Reservoir-surface areas ranged from 0.2 to 146 hectares and depths ranged from 0.01 to 6.0 meters.

Of the reservoirs studied, six generally had water quality that would not be detrimental to fish. Most of the reservoirs were enriched with nutrients and supported large concentrations of phytoplankton and dense growths of aquatic plants. In late winter and late summer, enrichment of shallow reservoirs often resulted in dissolved-oxygen concentrations less than 5.0 milligrams per liter, which is detrimental to fish.

The reservoirs studied provide different degrees of habitat for waterfowl. Three reservoirs lacked aquatic plants for waterfowl habitat. During the non-winter months, four reservoirs had dissolved-oxygen concentrations of less than 2.2 milligrams per liter in the bottom water that might be critical to the protection of waterfowl if botulism were to occur.

Specific conductance of water samples from three reservoirs was sufficiently close to the criterion of 4,800 microsiemens per centimeter at 25° Celsius to be regarded as potentially hazardous to livestock. In addition, species of phytoplankton potentially toxic to livestock were collected from eight reservoirs. However, most reservoirs had water quality that was satisfactory for livestock watering.

Water quality of the reservoirs generally would not be conducive to swimming. Visibility was limited in most of the reservoirs and eye irritation caused by large pH values could occur in late summer. In addition, leech populations and growths of submersed aquatic plants in most of the reservoirs would be a nuisance to swimmers.

INTRODUCTION

Several small lakes and reservoirs in northeastern Montana range from 0.2 to 146 ha in surface area and from 0.01 to 6.0 m in depth. The lakes, commonly termed prairie potholes, are natural depressions in the land surface that have resulted from glacial processes (Alden, 1932). Generally, these lakes have no surface-water outflow, and water levels are controlled by surface-water inflow, ground-water

inflow and outflow, and evaporation. Many of the lakes provide water for livestock during the grazing months. The reservoirs were formed by earth-filled dams located on small ephemeral streams, which flow mostly during spring snowmelt and summer rainstorms. The U.S. Bureau of Land Management constructed most of the dams to provide water for livestock and to serve as sediment traps to help decrease erosion in selected areas. The only outflow of surface water from the reservoirs is over the dam or through constructed earthen spillways. Water losses from the reservoirs occur by seepage through and around each dam, evaporation from the water surface, and transpiration by aquatic and riparian vegetation. For convenience, the term "reservoir" is used in this report to refer to both lakes and reservoirs in the study area.

Some of the reservoirs support various species of fish and provide adequate habitat for waterfowl. Fish stocking and waterfowl habitat-improvement programs have been conducted to further develop use of these reservoirs.

The U.S. Bureau of Land Management has entered into a cooperative program with the U.S. Geological Survey to study the potential uses of several reservoirs under their jurisdiction in Valley and Phillips Counties, Montana. The Bureau of Land Management is interested in data that could aid in managing the reservoirs for fish propagation, waterfowl habitat, livestock watering, and recreation use.

The evaluation of several reservoirs in Valley and Phillips Counties for fish propagation is based on whether they could maintain populations of game fish year after year. Fish propagation has been successful in a few reservoirs stocked with rainbow trout (*Salmo gairdneri*), largemouth bass (*Micropterus salmoides*), and crappie (*Pomoxis* sp.). However, in other reservoirs, problems could occur in sustaining a resident fish population. Fish might grow well in certain reservoirs during the summer, but because of water-quality changes under ice, these same fish might be unable to survive during winter. Other reservoirs might have good growing conditions for fish during the entire year but never have the required water quality for proper embryonic development. Establishment of resident populations of fish in these types of reservoirs would be difficult.

Montana is located in the central flyway region of North America. The many reservoirs in the State provide many species of waterfowl with fresh and brackish water for nesting and feeding areas. Waterfowl use areas that range from temporarily flooded meadows to reservoirs several meters deep (Johnsgard, 1975). Reservoirs in Valley and Phillips Counties could provide an increased number of breeding and stopover areas for waterfowl, which include Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), and pintails (*Anas acuta*). Unlike fish, waterfowl are not restricted to the reservoirs they use. If the habitat is not satisfactory, waterfowl will not be attracted. Most studies of the welfare of waterfowl are concerned primarily with habitat improvement. Assuring that water quality is favorable for aquatic plants and unfavorable for disease organisms indirectly protects waterfowl.

Grazing livestock in Valley and Phillips Counties generally consist of cattle, sheep, and horses. Water-quality criteria pertaining to these animals are based on the daily quantity of water each type of animal consumes. This study is concerned with the concentrations of water-quality variables that would be detrimental to the welfare of the animal, rather than concentrations that would satisfy dietary requirements.

In this report, recreation is considered to be those activities that involve prolonged body contact with water. Body contact includes wading, swimming, and diving. For convenience, the term "swimming" will be used to include all three types of recreation. The greatest concern during swimming is the risk of ingesting water in quantities sufficient to pose a health problem if bacterial contamination is present.

### Purpose and scope

The purpose of this report is to present biological data and to compare the physical, chemical, and biological data to water-quality criteria that are desirable for the proposed reservoir uses. Comparisons of water quality to criteria are used to delineate those reservoirs having water quality that might preclude successful management for fish propagation, waterfowl habitat, livestock watering, and recreation. Water-quality values that exceed the criteria indicate that detrimental conditions exist or that conditions during sampling pose a risk to the proposed reservoir use. Although certain management decisions can be based on this study, this report does not address the number and types of fish that can be stocked, specific improvements that might create more waterfowl habitat, or the maximum number of cattle that a given reservoir can sustain.

A previous report (Ferreira, 1980) presents physical and chemical data collected from 12 reservoirs in Valley County. Physical and chemical data from 12 reservoirs in Phillips County can be obtained from the District Office in Helena, Mont.

### Study area

The location of the study area and water-quality sites is shown in figure 1. Sampled reservoirs 1 through 12 are in Valley County and reservoirs 13 through 24 are in Phillips County (table 1). The topography generally is flat except for breaks along the large streams. Grasses cover most of the landscape and willow and cottonwood trees are concentrated in localized areas where there is enough water for growth.

### Data collection and analysis

Reservoirs were sampled four times during 1978 in Valley County and four times during 1979 in Phillips County. The first sampling was in late February or early March when the water surface was ice covered. The second sampling was in May when no ice cover was present and the reservoirs presumably were at their maximum stage. The third sampling was in August when air temperatures were highest and thermal stratification was most possible. The last sampling was in October when water temperatures tended to be homogeneous and the reservoir water would easily mix during slight winds.

Vertical profiles of temperature, specific conductance, pH, and dissolved oxygen were made using a multiparameter instrument. In each reservoir, measurements were made near the dam, which was estimated to be the deepest part of the original stream channel.



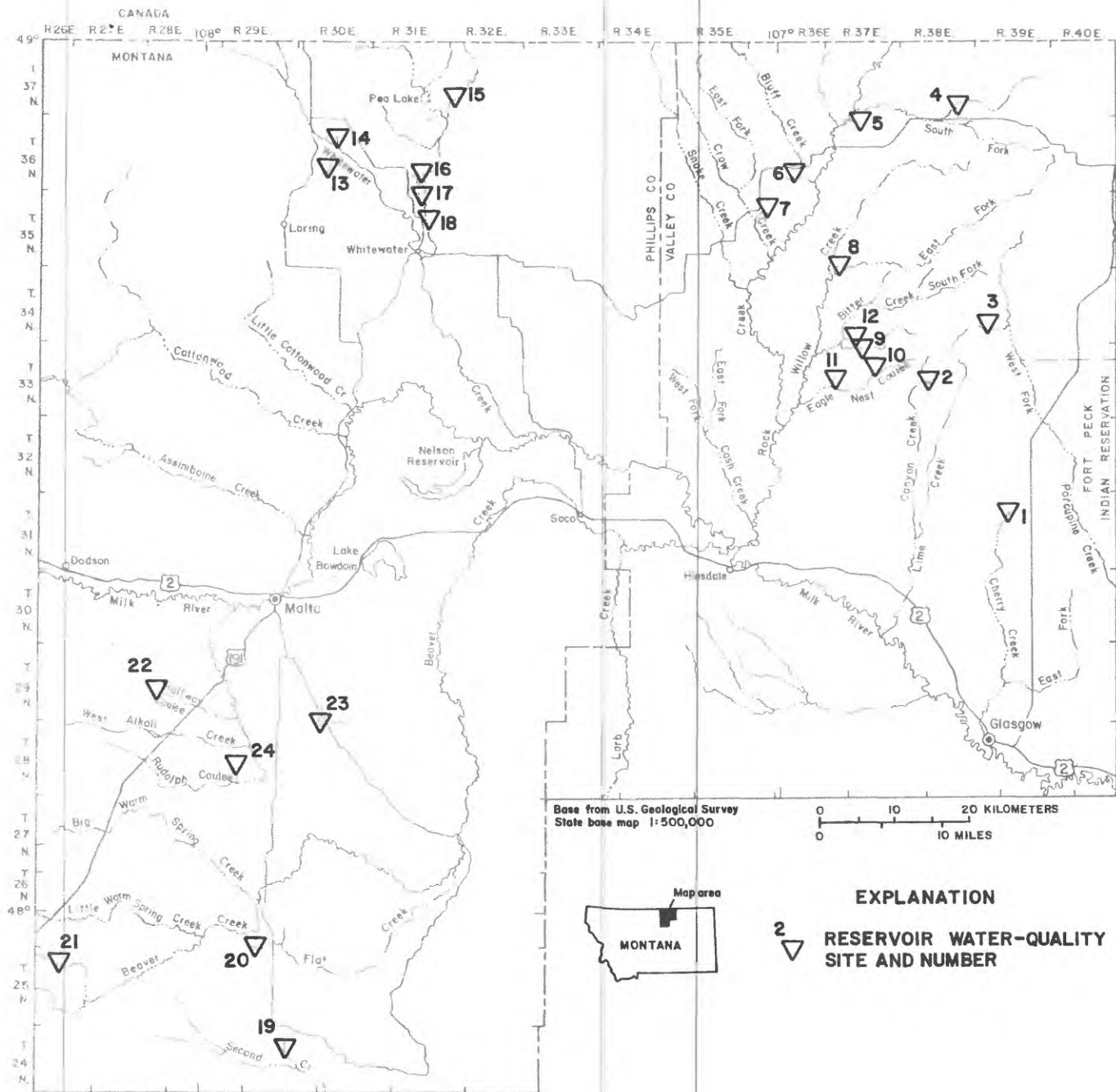


Figure 1.--Location of study area and reservoir water-quality sites.

Table 1.--Name and location of reservoirs sampled

| Reservoir              |                                     | Location  |            |
|------------------------|-------------------------------------|-----------|------------|
| Number                 | Name                                | Latitude  | Longitude  |
| <u>Valley County</u>   |                                     |           |            |
| 1                      | Air Base Pond                       | 48°26'40" | 106°35'30" |
| 2                      | Vador Reservoir                     | 48°35'40" | 106°43'10" |
| 3                      | VR-82                               | 48°40'00" | 106°37'40" |
| 4                      | VR-77                               | 48°55'20" | 106°41'40" |
| 5                      | Thoeny Reservoir                    | 48°53'50" | 106°51'20" |
| 6                      | Ich Pair Reservoir                  | 48°50'50" | 106°59'20" |
| 7                      | Near John Arnold Ranch              | 48°48'30" | 107°02'40" |
| 8                      | Near East Fork Willow Creek         | 48°44'50" | 106°53'40" |
| 9                      | Gay Reservoir                       | 48°38'30" | 106°51'10" |
| 10                     | VR-64                               | 48°37'30" | 106°50'00" |
| 11                     | Hose Reservoir                      | 48°37'00" | 106°54'20" |
| 12                     | Near Hinsdale Livestock<br>Company. | 48°39'50" | 106°50'40" |
| <u>Phillips County</u> |                                     |           |            |
| 13                     | Sharp Reservoir                     | 48°50'00" | 107°47'30" |
| 14                     | PR-22                               | 48°51'00" | 107°52'30" |
| 15                     | Alternate Reservoir                 | 48°56'00" | 107°32'00" |
| 16                     | Whitewater Lake (North)             | 48°50'00" | 107°37'30" |
| 17                     | Whitewater Lake (South)             | 48°49'00" | 107°35'30" |
| 18                     | Cool Pit Reservoir                  | 48°42'40" | 107°35'30" |
| 19                     | King Reservoir                      | 47°50'00" | 107°51'00" |
| 20                     | PR-18                               | 47°57'00" | 107°53'30" |
| 21                     | Parrot Flats                        | 48°01'00" | 108°15'00" |
| 22                     | PR-71                               | 48°16'00" | 108°04'00" |
| 23                     | Bennet Lake                         | 48°12'20" | 107°47'30" |
| 24                     | Empire Reservoir                    | 48°09'20" | 107°46'20" |

At the same location as the profiles, water samples were collected with an acrylic Kemmerer water sampler. When the reservoirs were deeper than 2 m, water samples were collected near the water surface and near the bottom. When the reservoirs were less than 2 m deep, water samples were collected at mid-depth. All samples were pretreated onsite according to methods of the U.S. Geological Survey (Friedman, 1979). Chemical constituents in water samples were analyzed at the U.S. Geological Survey laboratory in Denver, Colo., using methods described by Skougstad and others (1979).

Depth of light penetration was estimated with a Secchi disk. The depth of light penetration was considered to be the average depth of disappearance and reappearance of a black and white disk 200 mm in diameter (Hutchinson, 1967).

Water samples for analysis of total coliform, fecal coliform, and fecal streptococcal bacteria were collected at each chemical sampling site and along

the shore of easiest access to each reservoir. Bacteria were analyzed according to procedures described by Greeson and others (1977).

Three benthic-invertebrate samples were collected from deep-water to near-shore locations in each reservoir using an Eckman grab sampler having jaw dimensions of 152 X 152 mm. The results for the three samples from each reservoir were composited and expressed in number of organisms per square meter. Water samples for phytoplankton analyses were collected at the same locations as the samples for chemical analyses. Phytoplankton samples were collected in May and August in each of the reservoirs. Benthic invertebrates and phytoplankton were preserved and identified to species using procedures described by Greeson and others (1977).

Although the benthic-invertebrate numbers are reported per square meter, the values represent qualitative composite samples. The density value reported for each taxa does not mean that a given density is homogeneous throughout the reservoir bottom. The numbers represent only the relative number of organisms for each taxa collected in three samples and are used only for comparison among the reservoirs of the study area. A much more exhaustive sampling of each habitat zone would be needed to fully describe the benthic-invertebrate distribution in the study reservoirs.

#### RATIONALE FOR WATER-QUALITY CRITERIA

Water-quality criteria consist of values which, if not exceeded, will protect most, but not necessarily all, aquatic life and wildlife. The water-quality criteria used in this report are general and are based on major dissolved constituents, plant nutrients, trace elements, and biological analyses. The sets of water-quality variables used as criteria are different for each proposed reservoir use, and each set consists of several variables to provide a broad base for evaluation. In the following sections, the importance of selected water-quality variables and processes that could cause the reservoirs to not meet the criteria are discussed.

##### Depth

All reservoirs fill with sediment transported by inflowing water, which results in a decrease in water depth with time. Inflows of sediment can transport nutrients and other constituents that increase the productivity of reservoirs. Generally, reservoirs that have filled to 5 m or less in depth are enriched with nutrients and resultant phytoplankton concentrations that could effect stressful conditions for fish.

Although the depth of reservoirs is used mainly as a criterion indicative of eutrophic water, it can have an effect on other criteria. The large ratio of surface area to depth in shallow reservoirs allows a larger percentage of the total volume of water to be evaporated per unit of time than in deep reservoirs. Because of this larger percentage of water loss, the rate of concentrating dissolved constituents during the summer is increased in the shallow reservoirs. The larger percentage of water loss from ice formation during winter also results in a faster rate of concentrating dissolved constituents in shallow reservoirs compared to deep reservoirs.

### Secchi-disk depth

All natural waters contain matter which is either in the dissolved form or the suspended particulate form. Although both forms can impart a color to the water, the suspended particulate form has the greatest effect on the clarity of water (Wetzel, 1975). The quantity of suspended particulate matter can be estimated by the Secchi-disk depth. In many productive reservoirs, suspended particulate matter is composed mostly of phytoplankton, resulting in Secchi-disk depths of 2.5 m or less. Because phytoplankton populations continually change throughout the season, the clarity of water also changes. In some reservoirs, suspended particulate matter can be composed mostly of sediment, which could effectively suppress phytoplankton production by reflecting light needed for photosynthesis.

As a matter of safety, a criterion for clarity of water for swimming is visibility from the surface to a depth of 1.22 m. This value is more critical in areas where people might be diving.

### Dissolved solids and specific conductance

The major dissolved constituents determined for samples in this study are summed to give a measure of the salt concentration (calculated dissolved-solids concentration) of water. Many organisms, both plant and animal, have different tolerances to dissolved-solids concentrations and are unable to survive in reservoirs where the dissolved-solids concentration is too large.

Large concentrations of dissolved solids can cause detrimental physiological effects in fish. Dissolved-solids concentrations in excess of 15,000 mg/L (milligrams per liter) are reported as unsuitable for most species of freshwater fish (Rawson and Moore, 1944; U.S. Environmental Protection Agency, 1978). Most salmonids have been reported to survive dissolved-solids concentrations of 20,000 mg/L for 30 days (Forster and Goldstein, 1969). However, Swingle (1956) reports that concentrations in excess of 5,000 mg/L are unsuitable for spawning of largemouth bass (*Micropterus salmoides*), a species stocked in some reservoirs in the study area. Therefore, 5,000 mg/L is used as the safe limit for dissolved-solids concentration in this report. Based on the average ratio (1.6) between specific conductance and dissolved solids of water samples collected in Valley and Phillips Counties, the corresponding calculated limit for specific conductance would be 8,000  $\mu\text{S}/\text{cm}$ .

Many fish can tolerate large ranges in dissolved-solids concentrations. However, their ability to survive changes in dissolved-solids concentration depends on the time they have to acclimate to the new concentration. In shallow reservoirs, because the rate of concentrating dissolved solids is faster than in deep reservoirs, the time for fish acclimation is decreased, resulting in more stressful conditions for fish.

Water with excessive concentrations of dissolved solids can cause physiological upset or death of livestock. McKee and Wolf (1963) indicate that water in Montana having a maximum dissolved-solids concentration of 2,500 mg/L is good for all livestock, and water having a dissolved-solids concentration of 3,500 mg/L is considered fair for livestock. The criterion selected for this study is based on the report by the National Academy of Sciences and National Academy of Engineers (1973), which states that 3,000 mg/L of dissolved solids is satisfactory for all

livestock under most conditions. Based on the average ratio between specific conductance and dissolved solids of samples collected from the study reservoirs, the criterion protective of livestock for specific conductance would be 4,800  $\mu\text{S}/\text{cm}$ .

### pH

Values of pH greater than 8.0 in many reservoirs result from  $\text{CO}_2$  (carbon dioxide) use by aquatic plants during photosynthesis (Vallentyne, 1974). Nighttime respiration and decomposition, which add  $\text{CO}_2$  to the water, can decrease pH to toxic conditions.

Water having a pH of less than 4.5 is toxic to most species of fish, although fish can be affected at a pH of 5.0 (Fritz, 1980). In general, large concentrations of hydrogen ions, expressed as a small pH, affect fish by disrupting normal physiological processes. This disruption can increase the susceptibility of fish to disease and change predator-prey relationships. Both extremely large and extremely small concentrations of hydrogen ions also can increase the availability of toxic substances in water. Therefore, pH values ranging from 6.5 to 9.0 are considered protective of fish and fish food organisms. A more specific interpretation of the effects of pH on fish is difficult because toxic effects differ among species, populations, and age groups of the same species.

The pH criterion for waterfowl is 7.0 to 9.2, which is based on values at which submersed aquatic plants thrive best. The range of pH values listed as water-quality criteria is compared to pH of the study reservoirs during spring and summer when aquatic plants are at their maximum growth.

The pH of water is important to livestock because the concentration of hydrogen ions affects the solubility of toxic elements in water. Limits for pH (5.0 to 9.0) are taken from the suggested criteria for domestic water supplies (U.S. Environmental Protection Agency, 1978). Values of pH less than or greater than these limits could indicate potential toxicity from trace elements.

The lacrimal fluid of the human eye has a normal pH of about 7.4. Although strongly buffered, once buffering capacity of the fluid is exhausted during swimming, eye irritation results. The eyes could become irritated if the fluid in contact with the eye changes as little as 0.1 pH unit (National Technical Advisory Committee to the Secretary of the Interior, 1968). With eye irritation, there also could be subsequent infection. In most waters with pH values from 6.5 to 8.3, the buffering capacity of lacrimal fluid will prevent eye irritation during swimming.

### Dissolved oxygen

A major concern in reservoirs managed for fish propagation is the availability of dissolved oxygen. The solubility of oxygen in water is a function of water temperature, atmospheric pressure, and dissolved-solids concentration. Plants, through photosynthesis, produce oxygen and are responsible for increasing dissolved-oxygen concentration in water to more than saturation. Respiration by organisms and decomposition of organic matter are the main factors in water that can decrease the

concentration of dissolved oxygen to less than saturation. For most reservoir uses, large dissolved-oxygen concentrations are desirable.

The natural progression in the duration of a reservoir generally is a slow change from an oligotrophic state (unenriched with plant nutrients) to a eutrophic state (enriched). This process is termed eutrophication. With increases of nutrients, phytoplankton concentrations can increase significantly; then because of increased nighttime respiration, dissolved-oxygen concentrations can decrease to levels that are detrimental to other aquatic organisms. Nutrient and phytoplankton analyses can be used to indicate the trophic state of reservoirs.

Dissolved-oxygen requirements of fish depend on their species, age, and nutritional condition. Although some species of fish tolerate concentrations of dissolved oxygen less than 5.0 mg/L, this limit is considered to be the minimum concentration needed to maintain a diverse fish population. Dissolved-oxygen concentrations that become extremely small can result in fishkills. In eutrophic reservoirs an oxygen deficit can accumulate in water where gases are prevented from exchanging with the atmosphere. This condition can occur during winter under snow-covered ice and during summer in the deep water of stratified reservoirs (Nickum, 1970). After oxygen has become depleted fish additionally would be stressed from toxic effects of large concentrations of  $H_2S$  (hydrogen sulfide) (Johnson, 1970). Hydrogen sulfide is produced by sulfur-reducing bacteria during anaerobic decomposition (Hem, 1960).

Disease accounts for the largest percentage of nonhunting deaths of waterfowl (Bellrose, 1976). Botulism, which is caused by an anaerobic bacterium *Clostridium botulinum*, is a disease that can reach epidemic proportions. Water that does not become anaerobic helps prevent the spread of botulism. Therefore, reservoirs that have large dissolved-oxygen concentrations throughout the water column would be more suitable for waterfowl habitat than reservoirs that are anaerobic (no dissolved oxygen) near the bottom.

### Alkalinity

Alkalinity is a measure of the ability of water to buffer acid (hydrogen ions). To provide safety for fish against changes in hydrogen-ion loading, which in turn affects the toxicity of other constituents, the National Technical Advisory Committee to the Secretary of the Interior (1968) recommends a minimum of 20 mg/L alkalinity as  $CaCO_3$  (calcium carbonate) for protection of fish.

Generally, few waters with total alkalinity less than 25 mg/L of  $CaCO_3$  have been observed to support aquatic plants favorable to waterfowl. In temperate climates, shallow reservoirs with alkalinity concentrations greater than 25 mg/L of  $CaCO_3$  and with an adequate supply of nutrients can develop extensive growths of aquatic plants (Boyd, 1971). Aquatic plants not only benefit waterfowl but also provide food and shelter for other aquatic organisms that become additional food for waterfowl and fish.

### Nitrogen and phosphorus

Although nitrogen and phosphorus are major plant nutrients, they can be toxic in large concentrations. Nitrogen (N) can be toxic in the form of un-ionized

ammonia ( $\text{NH}_3$ ) or nitrite ( $\text{NO}_2^-$ ). In water, ammonia exists in both the un-ionized form ( $\text{NH}_3$ ) and the ionized form ( $\text{NH}_4^+$ ); however, most chemical analyses report both forms together as aqueous ammonia ( $\text{NH}_3 + \text{NH}_4^+$ ). The percentage of un-ionized ammonia increases with temperature and pH (Thurston and others, 1974).

Concentrations of aqueous ammonia for which the un-ionized ammonia component exceeds the criterion (0.016 mg/L, U.S. Environmental Protection Agency, 1978) for the protection of fish are given in table 2. In most reservoirs, the percentage of un-ionized ammonia increases during late summer as a result of a general increase in pH with photosynthesis.

Table 2.--Concentrations of aqueous ammonia ( $\text{NH}_3 + \text{NH}_4^+$ ) as N that contain an un-ionized ammonia concentration of 0.016 milligram per liter  $\text{NH}_3$  as N<sup>1,2</sup>

[°C, degrees Celsius]

| Temperature<br>(°C) | Concentration, in milligrams per liter |     |     |     |     |      |      |       |       |
|---------------------|--|-----|-----|-----|-----|------|------|-------|-------|
|                     | pH--6.0                                | 6.5 | 7.0 | 7.5 | 8.0 | 8.5  | 9.0  | 9.5   | 10.0  |
| 0                   | 200                                    | 63  | 20  | 6.3 | 2.0 | 0.65 | 0.22 | 0.079 | 0.036 |
| 5                   | 130                                    | 42  | 13  | 4.1 | 1.3 | .43  | .15  | .058  | .030  |
| 10                  | 88                                     | 28  | 8.9 | 2.8 | .90 | .30  | .10  | .044  | .025  |
| 15                  | 60                                     | 19  | 6.0 | 1.9 | .62 | .21  | .076 | .035  | .022  |
| 20                  | 41                                     | 13  | 4.2 | 1.3 | .43 | .15  | .058 | .030  | .021  |
| 25                  | 29                                     | 9.1 | 2.9 | .93 | .31 | .11  | .045 | .026  | .019  |
| 30                  | 20                                     | 6.5 | 2.1 | .66 | .22 | .081 | .037 | .023  | .019  |

<sup>1</sup> Modified after Thurston and others (1974).

<sup>2</sup> ( $\text{NH}_3 + \text{NH}_4^+$ ) as N equals nitrogen ammonia dissolved as N in the report by Ferreira (1980).

Nitrite interferes with oxygen transport in the bloodstream of animals, including fish. Most studies (Russo and others, 1974; Russo and Thurston, 1975) indicate that salmonids (salmon, trout, whitefish, and grayling) are more sensitive to large concentrations of nitrite than are warm-water species (bass, sunfish, and minnows). The U.S. Environmental Protection Agency (1978) concludes that 5 mg/L  $\text{NO}_2^-$  as N would be protective of warm-water fish and 0.06 mg/L  $\text{NO}_2^-$  as N would be protective of salmonids. For this study a safe criterion of 0.06 mg/L  $\text{NO}_2^-$  as N is used for the protection of all fish. Concentrations of this magnitude

generally are unlikely in most surface waters; however, such concentrations can be attained in water intensely used by livestock.

The nitrite criterion protective of livestock ( $10 \text{ mg/L NO}_2^-$  as N) is larger than for fish. Because nitrite is formed through the biological reduction of nitrate ( $\text{NO}_3^-$ ) in the rumen of cattle and sheep, a criterion of  $100 \text{ mg/L NO}_2^- + \text{NO}_3^-$  as N also is used.

Elemental phosphorus is considered toxic to fish in large concentrations, but this form of phosphorus rarely occurs in natural water and, therefore, is not included as a criterion. The most probable forms of phosphorus in natural waters are phosphate ions, complexes with metal ions, and colloidal particulate material. Although these forms of phosphorus are not considered toxic to animals, they can stimulate plant growth to nuisance conditions.

### Trace elements

Trace elements are included in water-quality criteria because of their possible toxic effects when concentrations are large. Different species of organisms and different life stages of the same species are able to tolerate different trace-element concentrations. Prescribing suitable criteria to protect each species would result in several values for each criterion. Therefore, the trace-element concentrations used for criteria in this study are approximate averages to protect most of the organisms considered.

In addition to the species of fish, trace-element toxicity will differ according to the form of the ion (valence) and the synergistic effects of other water-quality variables. Criteria for trace-element concentrations protective of fish generally are small because of the continuous exposure of fish gill structure to ions dissolved in water. However, the most recent criterion for mercury is  $0.00057 \text{ } \mu\text{g/L}$  (microgram per liter) (U.S. Environmental Protection Agency, 1980a); this concentration is so small that the detection limit of  $0.1 \text{ } \mu\text{g/L}$  for mercury analyses in the study is of limited use in evaluating potential mercury hazards.

The most commonly occurring trace element causing toxicity to waterfowl is lead. Lead poisoning in waterfowl occurs mainly from the toxic effect of ingested lead shot and not from concentrations of lead in water. Studies have indicated that ingestion of a single lead shot can result in a bird's death (Bellrose, 1976).

Trace-element criteria for the protection of livestock apply to all types of livestock. The margin of safety the criteria provide varies depending on the species of livestock, the conditions to which they are acclimated, and their health.

Trace-element concentrations toxic to man are not included as criteria for swimming, because the quantities most likely to be ingested would not be toxic. However, if there is a possibility of large quantities of water being ingested over a long interval of time,  $2.0 \text{ } \mu\text{g/L}$  of mercury,  $10.0 \text{ } \mu\text{g/L}$  of cadmium or selenium, and  $50 \text{ } \mu\text{g/L}$  of chromium, lead, or silver are drinking-water standards that would provide protection for swimmers (U.S. Environmental Protection Agency, 1977).



## Phytoplankton, benthic invertebrates, and fecal coliform

Biological analyses that would be helpful in evaluating the study reservoirs are species identification of phytoplankton and benthic invertebrates and enumeration of fecal bacteria. A balance of phytoplankton and benthic invertebrates would be beneficial as food organisms for fish and waterfowl. Fecal bacteria are not beneficial; however, their density indicates the suitability of water for recreation.

Although phytoplankton serve as food for fish and other aquatic organisms, large phytoplankton concentrations can result in small dissolved-oxygen concentrations (see dissolved-oxygen section). Large phytoplankton concentrations generally occur in early spring when nutrients are transported to the reservoirs by spring runoff, and late summer when warm water temperatures stimulate phytoplankton reproduction. During these intervals, byproducts from some phytoplankton taxa can attain potentially toxic concentrations.

The presence of benthic invertebrates in a reservoir indicates the availability of food for fish and waterfowl. Generally, their number and type also indicate unfavorable or favorable conditions for fish propagation. A large number of organisms evenly distributed among several taxa (types) of organisms indicates a balanced stable community that would be best for fish propagation.

Feces and urine of warm-blooded animals probably are the most significant potential sources of waterborne pathogens (bacteria that cause diseases in man). Diseases can be of the skin, eyes, ears, nose, and urogenital system. Pathogens that are responsible for diseases of the intestinal tract include species of the genera *Salmonella*, *Shigella*, and *Escherichia* (Greeson, 1981). Pathogens that occur in bathing waters and can cause disease even when not ingested are *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* (U.S. Environmental Protection Agency, 1978).

The use of fecal coliform bacteria as a water-quality criterion for swimming is related to the probable occurrence of waterborne pathogens for a given concentration of fecal coliform bacteria. In freshwater, *Salmonella* has been recovered in 85 to 98 percent of samples having fecal coliform concentrations ranging from 201 to 2,000 organisms per 100 mL (U.S. Environmental Protection Agency, 1978) and could be about 100 percent with fecal coliform concentrations greater than 2,000 organisms per 100 mL (Geldreich, 1972).

The criterion for fecal coliform for the protection of swimmers is based on a minimum of five samples collected and analyzed during an interval of 30 days. According to the U.S. Environmental Protection Agency (1978), the log mean of fecal coliform bacteria samples should not exceed 200 coliform organisms per 100 mL for the protection of people who directly contact water by swimming. Because this study was of a reconnaissance nature, the number of fecal coliform samples collected was less than the minimum number specified to compute a log mean. However, 200 fecal coliform organisms per 100 mL is used as a maximum criterion in this report to delineate reservoirs in which contamination might exist.

The ratio of fecal coliform to fecal streptococcus bacteria (FC/FS) can indicate the source of pollution, particularly in distinguishing human waste from livestock and waterfowl wastes. Although the ratios of fecal coliform to fecal streptococcus bacteria for ducks, sheep, and cattle are shown in figure 2, the ratio from a single sample of water does not necessarily indicate which animal is

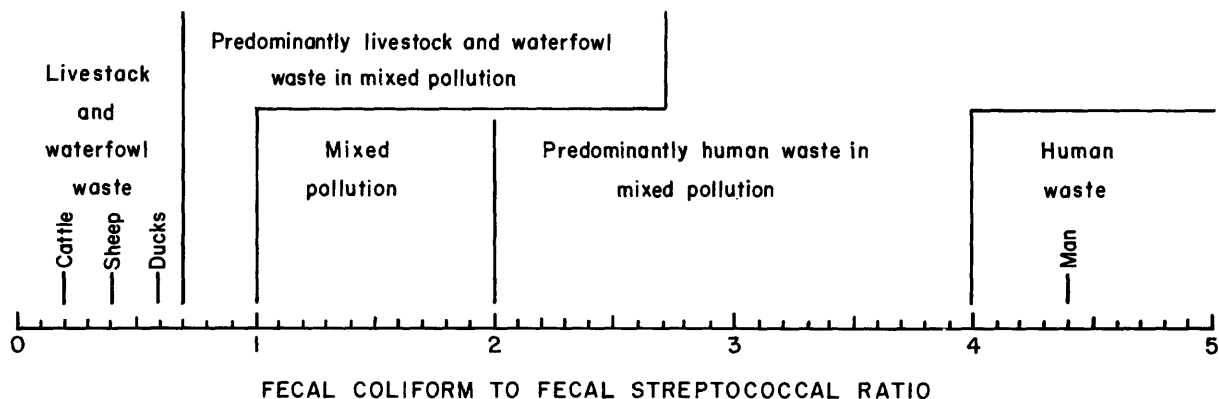


Figure 2.--Relationship of fecal bacteria to source of pollution. The FC/FS ratio equals the number of fecal coliform organisms per 100 milliliters divided by the number of fecal streptococcal organisms per 100 milliliters.

the source of pollution. A larger number of samples would allow a more accurate interpretation of the pollution source. A significant limitation in the use of bacterial ratios is that a combination of animal types as the source of fecal contamination along with bacterial die-off could yield a ratio similar to the ratio of any one animal type. Therefore, these ratios need close evaluation. If a reservoir is to be developed for swimming, grazing records would be useful in delineating recent livestock sources of fecal contamination as opposed to waterfowl sources.

#### COMPARISON OF WATER-QUALITY CRITERIA TO RESERVOIR DATA

Water-quality criteria presented in this report provide a large range of values within which fish propagation, waterfowl habitat, livestock watering, and recreation can be managed successfully. The criteria are general estimates of the minimum or maximum "safe" water-quality values beyond which specific organisms might be harmed physiologically. Therefore, a comparison of the criteria to the data collected from the reservoirs serves only as a guideline for management. More specific criteria will be needed for individual reservoir and watershed management.

Although samples were collected during the winter, spring, summer, and autumn the reconnaissance nature of this study did not define seasonal or diel water-quality changes in the reservoirs. Substantial seasonal and diel water-quality changes in a reservoir can result from fluctuations in water content and succession of large populations of phytoplankton. At times these water-quality changes can be detrimental to fish, making knowledge of detailed water-quality changes important before any full-scale reservoir management plan can be developed.

There are two notable limitations in using the data from this study for management: (1) Samples were collected from a single location and, therefore, may not represent conditions at other locations of the reservoir, and (2) no replicate analyses were made to provide an estimate of water-quality variability, which would allow proper evaluation of values that exceed the criteria. Because of

these limitations the possibility exists that a reservoir might be managed successfully even though several water-quality variables exceed the criteria.

### Fish propagation

Water-quality criteria that would protect fish against toxicity of selected water-quality variables are listed in table 3. A comparison of reservoir water quality determined by analyses to water-quality criteria for the protection of fish is given in table 4.

Table 3.--*Water-quality criteria for protection of fish against toxicity of selected water-quality variables*

[Abbreviations: mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25° Celsius; min, minimum; max, maximum; EPA, U.S. Environmental Protection Agency; NTAC, National Technical Advisory Committee to the Secretary of the Interior]

| Variable   | Criteria   |            |             | Source                      |
|--|--|------------|-------------|-----------------------------|
| Dissolved solids   | 5,000 mg/L, max                                  |            |             | Swingle (1956).             |
| Specific conductance   | 8,000 µS/cm, max                                 |            |             | See text.                   |
| pH   | 6.5-9.0, min-max                                 |            |             | EPA (1978).                 |
| Dissolved oxygen   | 5.0 mg/L, min                                    |            |             | EPA (1978).                 |
| Alkalinity, total  | 20 mg/L CaCO <sub>3</sub> , min                  |            |             | NTAC (1968).                |
| Ammonia, dissolved   | 0.016 mg/L NH <sub>3</sub> as N, max             |            |             | EPA (1978);<br>See table 2. |
| Nitrite, dissolved   | 0.06 mg/L NO <sub>2</sub> <sup>-</sup> as N, max |            |             | EPA (1978).                 |
| Arsenic, total   | 440 µg/L, max                                    |            |             | EPA (1980b).                |
| Total recoverable:   |  |            |             |                             |
| Copper   | 5.6 µg/L, max                                    |            |             | EPA (1980b).                |
| Iron   | 1,000 µg/L, max                                  |            |             | EPA (1978).                 |
| Manganese  | 1,000 µg/L, max                                  |            |             | McKee and Wolf (1963).      |
| Mercury  | 0.00057 µg/L, max                                |            |             | EPA (1980a).                |
| Selenium   | 35 µg/L, max                                     |            |             | EPA (1980b).                |
| Zinc   | 47 µg/L, max                                     |            |             | EPA (1980b).                |
| Maximum concentration at hardness (as calcium carbonate) of: | 75 mg/L  | 150 mg/L   | 300 mg/L    |                             |
| Total recoverable:   |  |            |             |                             |
| Cadmium  | 0.019 µg/L                                       | 0.038 µg/L | 0.079 µg/L  | EPA (1980b).                |
| Chromium   | 3,400 µg/L                                       | 7,300 µg/L | 15,000 µg/L | EPA (1980b).                |
| Lead   | 2.9 µg/L   | 9.9 µg/L   | 51 µg/L     | EPA (1980b).                |
| Nickel   | 77 µg/L  | 130 µg/L   | 220 µg/L    | EPA (1980b).                |
| Silver   | 2.5 µg/L   | 8.2 µg/L   | 27 µg/L     | EPA (1980b).                |

Table 4.--Comparison of reservoir water quality to water-quality criteria for the protection of fish  
[X denotes water-quality variables that do not meet the criterion in at least one sample]

| Variable             | Reservoir |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----------------------|-----------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                      | 1         | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Dissolved solids     | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  | -  | -  | -  | -  | -  |
| Specific conductance | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | X  | X  | -  | -  | -  | X  | -  | -  | -  |
| pH                   | -         | X | - | - | - | X | X | X | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | -  | -  | X  | X  |
| Dissolved oxygen     | X         | X | X | X | - | - | X | - | X | -  | X  | -  | -  | X  | -  | -  | -  | X  | X  | X  | -  | X  | X  | X  |
| Alkalinity           | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Ammonia              | -         | - | - | - | - | - | X | X | - | -  | -  | -  | X  | X  | X  | X  | X  | X  | -  | X  | X  | -  | -  | X  |
| Nitrite              | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Arsenic              | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Cadmium              | X         | X | X | X | X | X | X | X | X | X  | X  | X  | -  | -  | -  | X  | X  | -  | X  | X  | X  | X  | X  | X  |
| Chromium             | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Copper               | X         | X | X | X | X | X | X | X | X | X  | X  | X  | -  | -  | -  | X  | X  | -  | -  | -  | X  | -  | -  | -  |
| Iron                 | -         | - | - | X | X | X | - | - | - | X  | -  | -  | X  | -  | -  | X  | X  | -  | -  | -  | X  | X  | -  | X  |
| Lead                 | X         | X | X | X | X | X | X | X | - | X  | X  | X  | X  | X  | X  | -  | -  | X  | X  | X  | X  | X  | -  | X  |
| Manganese            | X         | - | X | - | - | - | X | - | - | -  | -  | -  | X  | -  | -  | -  | -  | -  | -  | -  | X  | X  | X  | -  |
| Mercury              | -         | - | - | X | X | - | - | X | X | X  | X  | X  | X  | X  | X  | -  | -  | X  | X  | X  | X  | X  | -  | -  |
| Nickel               | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  |
| Selenium             | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Silver               | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Zinc                 | -         | - | - | X | X | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  |

The concentration of dissolved solids and the specific conductance in the study reservoirs generally were not detrimental to fish. Reservoirs 5, 6, 10, 15-17, and 21 are shallow and were frozen to the bottom during times of winter sampling. The shallowness of these reservoirs makes them susceptible not only to winter freezing but also to possible summer desiccation during years of deficient precipitation. At times this factor alone would prevent fish propagation in these reservoirs. During years when these reservoirs do not freeze to the bottom or become desiccated, large dissolved-solids concentrations could be stressful for fish. This condition especially would be true for reservoirs 16, 17, and 21 which have the largest surface areas (115 to 146 ha) and shallowest depths (0.01 to 1.0 m). Only reservoirs 16, 17, and 21 had samples indicating dissolved-solids concentrations close to or larger than the criteria. All three reservoirs had samples with specific-conductance values exceeding the criterion protective of fish (table 4).

Reservoirs 3, 4, 7, 18, and 23 also are shallow (1.0 to 3.0 m deep); however, they did not freeze to the bottom during the winter. They had large concentrations of dissolved solids (276 to 1,830 mg/L) in the water under winter ice. These reservoirs exceeded many of the water-quality criteria during the summer because of increased concentrations of all constituents with evaporation.

The pH values for the late August and early October surface samples of most of the reservoirs were larger than the criterion. The largest pH value in the study area, measured in reservoirs 10, 12, 14, 18, and 20, was 9.8 in the August samples.

Large values of pH and phytoplankton concentrations occurred together only in reservoir 20 (pH = 9.8, phytoplankton = 67,603 cells per mL), which has an extremely large phytoplankton concentration compared to the other reservoirs. The non-correlation between pH and phytoplankton concentration in the other reservoirs probably results from the physiological health of algal cells, the different inhibitory or stimulatory algal-growth conditions present in each reservoir, and the existence of submersed and floating aquatic plants, which also can affect water quality.

All reservoirs in the study area can be classified as eutrophic, based on their large nutrient concentrations and resultant phytoplankton populations (tables 5, 6, and 15; table 15 at back of report). Consequently, all these reservoirs

Table 5.--Selected criteria indicative of eutrophic conditions in reservoirs

[Abbreviations and symbols: m, meter; mg/L, milligrams per liter; mL, milliliters;  $\leq$ , equal to or less than;  $\geq$ , equal to or greater than]

| Variable   | Criteria  | Source                                       |
|--|---|--|
| Reservoir depth  | $\leq$ 5 m  | Nickum (1970).                               |
| Secchi disk depth  | $\leq$ 2.5 m  | Taylor and others (1980).                    |
| Nitrogen, total  | $\geq$ 1.1 mg/L N   | Wetzel (1975).                               |
| Orthophosphate, dissolved  | $\geq$ 0.025 mg/L PO <sub>4</sub> as P  | U.S. Environmental Protection Agency (1978). |
| Phosphorus, total  | $\geq$ 0.03 mg/L P  | Taylor and others (1980).                    |
| Phytoplankton concentration  | $\geq$ 15,000 cells per mL  | Taylor and others (1980).                    |
| Phytoplankton, dominant taxa ( $\geq$ 15 percent of total cells per mL). | <i>Ceratium</i> ,<br><i>Peridinium</i> ,<br><i>Melosira</i> ,<br><i>Stephanodiscus</i> , and<br><i>Pediastrum</i> . | Naumann (1931), cited in Hutchinson (1967).  |
|  | <i>Cyclotella nana</i>  | Taylor and others (1980).                    |
|  | <i>Anabaena</i> ,<br><i>Aphanizomenon</i> ,<br><i>Microcystis</i> , and<br><i>Oscillatoria rubescens</i> .          | Fruh and others (1966).                      |
|  | <i>Microcystis flos-aquae</i>   | Rawson (1956).                               |
|  | <i>Cosmarium punctulatum</i> ,<br><i>Staurastrum polytrichum</i> ,<br>and<br><i>Micrasterias apiculata</i> .        | Coesel and others (1978).                    |

Table 6.--Reservoirs in which depth and water quality of samples indicate eutrophic conditions

[X denotes water-quality variables that do not meet the criterion in at least one sample]

| Variable                     | Reservoir |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|------------------------------|-----------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                              | 1         | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Reservoir depth              | -         | - | X | X | X | X | X | X | X | X  | -  | X  | X  | -  | X  | X  | X  | X  | X  | -  | X  | X  | X  | X  |
| Secchi-disk depth            | X         | X | X | X | X | X | X | X | X | X  | X  | X  | X  | -  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Nitrogen, total              | X         | X | X | X | X | X | X | X | - | X  | X  | X  | X  | X  | X  | -  | X  | X  | X  | X  | X  | X  | X  | X  |
| Orthophosphate, dissolved    | X         | - | - | X | X | X | X | X | - | X  | -  | -  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Phosphorus, total            | X         | X | X | X | X | X | X | X | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Phytoplankton concentration  | X         | X | - | - | - | - | - | - | - | -  | X  | -  | X  | -  | -  | -  | -  | -  | X  | X  | -  | -  | -  | X  |
| Phytoplankton, dominant taxa | X         | X | X | X | - | X | X | X | X | X  | -  | -  | X  | X  | X  | -  | -  | X  | X  | X  | -  | -  | -  | X  |

have the potential of attaining dissolved-oxygen concentrations less than the criterion protective of fish.

Although reservoirs 5, 12, 16, 17, and 21-23 had nutrient concentrations indicative of eutrophic waters, they did not have phytoplankton concentrations greater than or equal to 15,000 cells per mL or phytoplankton taxa indicative of eutrophic water. These reservoirs, except for 22 and 23, also did not contain extremely small dissolved-oxygen concentrations near the bottom that commonly are associated with large phytoplankton concentrations (less than 3.5 mg/L). Reservoirs 5, 16, 17, and 21 had the shallowest Secchi-disk measurements (0.0 to 1.8 m), indicating that limited light might have suppressed phytoplankton production. The large concentration of suspended sediment in these reservoirs prevented phytoplankton analysis for verification of suppressed production; however, the light-grayish-brown color of the reservoirs is not indicative of water having large concentrations of phytoplankton. At reservoir 12 there could be a limiting factor not sampled that prevents phytoplankton from attaining large populations. Reservoirs 22 and 23 contained dissolved-oxygen concentrations less than saturation, which indicates that large quantities of organic material have decomposed. The source could have been phytoplankton or other plant production at some earlier time.

The most stressful dissolved-oxygen conditions for fish occurred under ice conditions in reservoirs 1, 3, 4, 7, 18, 20, and 23. In late winter these reservoirs had undersaturated dissolved-oxygen concentrations of less than 1.5 mg/L in most of the water column. Conversely, reservoirs 2, 8, 12, and 19 had supersaturated dissolved-oxygen concentrations during winter sampling. Clear ice and lack of snow cover could have allowed light transmission for photosynthesis, which resulted in the supersaturated dissolved-oxygen concentrations. Supersaturation under ice is common in reservoirs that have clear ice with little or no snow cover and sunny days (Nickum, 1970).

Most dissolved-oxygen concentrations less than the criterion for protection of fish, other than those that occurred in winter, occurred in the bottom waters of stratified reservoirs during late summer. Fish could survive in these reservoirs during these times by staying in the upper waters. However, stress and possibly death of fish might result when the reservoirs mix either during strong winds or during autumn overturn.

Reservoirs 1, 2, 8, 9, 11-14, 19, 20, 22, and 24 had depths ranging from 1.7 to 6.5 m. Their large volume of water per surface area during the summer provides a large pool of dissolved oxygen from which the demands of respiration and decomposition can be satisfied. These reservoirs generally had dissolved-oxygen concentrations in at least part of the water column that were larger than the criterion for the protection of fish. The largest difference in dissolved-oxygen concentration between surface and bottom waters occurred in reservoirs 1, 2, and 20 which had depths ranging from 4.5 to 5.0 m in August. The dissolved-oxygen concentrations in these reservoirs were less than 2.0 mg/L near the bottom and ranged from 5.9 to 9.3 mg/L near the water surface.

Reservoir 13 was the shallowest reservoir that had dissolved-oxygen concentrations larger than the criterion protective of fish. Reservoir 13 had a depth of 1.7 m at the sampling point during the winter. The nutrient values, the dominant phytoplankton taxa, and the phytoplankton concentrations in the reservoir indicated eutrophic conditions. However, the dissolved-oxygen concentration was larger than the criterion at all measured depths during each sampling. The dissolved-oxygen concentration could be smaller than 5.0 mg/L during the night because of respiration by the large concentrations of phytoplankton (39,101 and 66,609 cells per mL).

Hydrogen sulfide ( $H_2S$ ) odor, which indicates anaerobic conditions, was detected in the bottom water of reservoir 13 during winter sampling. In reservoirs where the dissolved-oxygen concentration from bottom water samples was less than 2.0 mg/L,  $H_2S$  odor commonly was detected. In these reservoirs and reservoir 13, anaerobic conditions most likely exist just above and in the bottom sediments. However, the physical limitations of the measuring instrument prevented measurement of anaerobic conditions next to and in the bottom sediment of the reservoirs.

Alkalinity in all reservoirs was larger than the minimum criterion. Fish in the study reservoirs would be protected against the effects of inflows of water having pH values of less than 7.0.

Reservoir 13 and deep reservoirs 20 and 24, all of which had dissolved-oxygen concentrations larger than the criterion, had ammonia concentrations that might be critical to the protection of fish. In August, reservoirs 13 and 24 had dissolved  $NH_3$  concentrations that are about 2.5 times larger than the criterion. Reservoir 20 had an August concentration of 0.44 mg/L dissolved  $NH_3$ , which is more than 20 times larger than the criterion protective of fish. These reservoirs could pose a large risk if managed for fish propagation.

With the exception of reservoirs 16 and 17, the reservoirs in this study did not show nitrite concentrations that would be detrimental to fish. Reservoir 16 had 0.05 mg/L of  $NO_2^-$  in August and reservoir 17 had 0.06 mg/L of  $NO_2^-$  in October. Both reservoirs could have had nitrite concentrations in excess of the criterion during times, or at locations, not sampled.

Concentrations of trace elements generally were larger in the bottom water samples of reservoirs than in the top water samples. This situation could have resulted from upwelling of bottom sediments during sampling or from sampling sediment naturally suspended in the more dense water near the bottom. Although fish could avoid the large concentrations of trace elements in deep water, they would be subjected to increased concentrations during autumn overturn when the reservoir completely mixes.

Eight trace elements occurred in one or more reservoirs in excess of the criteria for the protection of fish (table 4). Only reservoir 21 contained excess concentrations of all eight trace elements. Most of the reservoirs had cadmium, copper, lead, and mercury in excess of the criteria. Cadmium concentrations were most critical in reservoirs 5 and 7, both of which contained 6  $\mu\text{g/L}$ . Reservoirs 5, 16, 17, and 21 had large concentrations of total recoverable copper (6 to 19  $\text{mg/L}$  in reservoirs 5, 16, and 17; 620  $\mu\text{g/L}$  at reservoir 21). Concentrations of total recoverable lead were largest in reservoirs 1, 2, 5, 6, 7, and 21. In reservoirs with concentrations of total recoverable mercury greater than the criterion, the range was from 0.1 to 0.2  $\mu\text{g/L}$ . Iron, manganese, nickel, and zinc were present in excess of the criteria protective of fish in less than one-half of the study reservoirs. Nickel in excess of the criterion was detected only in reservoir 21.

Although all reservoirs contained one or more trace elements in excess of the criteria for the protection of fish, the concentrations were not toxic to all organisms. Benthic invertebrates were collected in all reservoirs (table 16 at back of report) and fish were observed in reservoirs 1, 9, and 11. In those reservoirs that are not affected by toxic trace elements, the large nutrient concentrations characteristic of the study reservoirs could provide for a productive fishery if fish are harvested at a rate in balance with production.

The largest concentration of benthic invertebrates generally occurred in the August samples, which were collected when most benthic invertebrates were in their largest life stage and could be detected easily. Shore samples consisted mostly of Amphipoda species (scuds). Diptera (flies) were the dominant group of benthic invertebrates inhabiting the deeper areas of the reservoirs. Dipteran genera of the family Chironomidae (*Chironomus*, *Paratanytarsus*, and *Procladius*) had a greater frequency of occurrence than other dipteran families. These genera are detritus feeders. They can inhabit areas of small dissolved-oxygen concentrations and large quantities of particulate organic material, which typifies the reservoir bottoms of the study area.

In reservoir 5 only four types of organisms were collected, none of which were present in large number. The paucity of benthic invertebrates collected from reservoir 5 differentiates this reservoir from the other reservoirs in the study area. Either the large quantity of suspended material or some other water-quality variable was limiting the growth of benthic invertebrates in reservoir 5. Therefore, the reservoir also would be limiting to fish propagation.

#### Waterfowl habitat

Water-quality criteria that would protect waterfowl against disease and maintain desirable habitat are listed in table 7. A comparison of reservoir water quality determined by analyses to water-quality criteria for the protection of waterfowl is given in table 8.

Reservoirs 7-12 exceeded the pH criteria for the protection of aquatic plants, but they generally supported growths of submersed and emersed plants. This plant growth indicates that the degree to which pH is exceeded in the study area may not be critical to the reservoirs. A mitigating factor is the short length of time that the reservoirs have large pH values. Large pH values generally occur in late summer, probably as a result of increased phytoplankton production.



Table 7.--Water-quality criteria for the protection of waterfowl against disease and for the maintenance of desirable waterfowl habitat

[Abbreviations: mg/L, milligrams per liter; min, minimum; max, maximum; NTAC, National Technical Advisory Committee to the Secretary of the Interior]

| Variable          | Criteria                        | Source       |
|-------------------|---------------------------------|--------------|
| pH                | 7.0-9.2, min-max                | NTAC (1968). |
| Dissolved oxygen  | Greater than 0 mg/L             | NTAC (1968). |
| Alkalinity, total | 25 mg/L CaCO <sub>3</sub> , min | NTAC (1968). |

Anaerobic conditions were not measured in the reservoirs of the study area. However, based on the small dissolved-oxygen concentrations measured near the bottom of many of the study reservoirs in spring and summer, anaerobic conditions possibly existed in the bottom sediments when water circulation was minimal. Reservoirs 1, 2, 18, 20, and 22 had minimal dissolved-oxygen concentrations in their bottom water (table 8), which represents unhealthy conditions if disease such as botulism were to occur. Reservoirs 1, 2, 20, and 22 had the most critical dissolved-oxygen concentrations in the bottom water (less than 2.2 mg/L). The severity of conditions would be dictated by the extent of oxygen depletion and the number of waterfowl using the area.

Table 8.--Comparison of reservoir water quality to water-quality criteria for the protection of waterfowl  
[X denotes water-quality variables that do not meet the criterion in at least one sample]

| Variable         | Reservoir |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|------------------|-----------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                  | 1         | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| pH               | -         | - | - | - | - | - | X | X | X | X  | X  | X  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Dissolved oxygen | X         | X | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | X  | -  | X  | -  | -  |
| Alkalinity       | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  |

Reservoir 24 was the only reservoir that had total alkalinity concentrations less than the criterion for good growth of aquatic plants. There were no emerged aquatic plants at this reservoir; however, submersed aquatic plants were present but not abundant. This reservoir could evolve into a more suitable habitat for waterfowl if growths of emerged plants complemented the submersed plants as the reservoir ages.

Even though reservoirs 16, 17, and 21 were within the water-quality criteria for the protection of waterfowl, waterfowl habitat in the form of emerged aquatic plants was lacking. These reservoirs and other reservoirs where waterfowl habitat improvement is desired might possibly be seeded with species of aquatic plants compatible with the water quality.

### Livestock watering

Water-quality criteria for the protection of livestock are presented in table 9. A comparison of reservoir water quality determined by analyses to water-quality criteria for the protection of livestock is given in table 10.

Table 9.--Criteria for protection of livestock against toxicity of selected water-quality variables

[Abbreviations: mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter; min, minimum; max, maximum; EPA, U.S. Environmental Protection Agency; NAS/NAE, National Academy of Sciences and National Academy of Engineers]

| Variable  | Criteria   | Source                    |
|---|--|---------------------------|
| Dissolved solids                                | 3,000 mg/L, max  | NAS/NAE (1973).           |
| Specific conductance                            | 4,800 µS/cm, max   | See text.                 |
| pH  | 5.0-9.0, min-max   | EPA (1978).               |
| Fluoride, total recoverable                     | 2.0 mg/L, max  | NAS/NAE (1973).           |
| Nitrite plus nitrate,<br>dissolved.             | 100 mg/L as N, max   | NAS/NAE (1973).           |
| Nitrite, dissolved                              | 10 mg/L as N, max  | NAS/NAE (1973).           |
| Sulfate, dissolved                              | 2,500 mg/L, max  | Digesti and Weeth (1973). |
| Arsenic, total                                  | 200 µg/L, max  | NAS/NAE (1973).           |
| Boron, total                                    | 5,000 µg/L, max  | NAS/NAE (1973).           |
| Total recoverable:                              |  |                           |
| Chromium  | 1,000 µg/L, max  | NAS/NAE (1973).           |
| Copper  | 500 µg/L, max  | NAS/NAE (1973).           |
| Lead  | 100 µg/L, max  | NAS/NAE (1973).           |
| Mercury   | 0.15 µg/L, max   | EPA (1980a, 1980b).       |
| Selenium  | 50 µg/L, max   | NAS/NAE (1973).           |
| Vanadium  | 100 µg/L, max  | NAS/NAE (1973).           |
| Zinc  | 25,000 µg/L, max   | NAS/NAE (1973).           |
| Phytoplankton, taxa that<br>can produce toxins. | <i>Aphanizomenon flos-aquae</i> ,<br><i>Anabaena flos-aquae</i> ,<br><i>Coelosphaerium Kuetzingianum</i> ,<br><i>Gloeotrichia echinulata</i> ,<br><i>Microcystis eruginosa</i> , and<br><i>Nodularia spumigena</i> . | NAS/NAE (1973).           |

Generally, the reservoirs are satisfactory for stockwatering. The large ratio of surface area to volume of reservoirs 16, 17, and 21 renders them susceptible to extensive concentrating of dissolved solids by evaporation. Reservoir 16 had dissolved-solids concentrations and reservoirs 16 and 17 had specific-conductance

Table 10.--Comparison of reservoir water quality to water-quality criteria for the protection of livestock

[X denotes water-quality variables that do not meet the criterion in at least one sample]

| Variable                  | Reservoir |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|---------------------------|-----------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                           | 1         | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Dissolved solids          | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  | -  | -  | -  | -  | -  |
| Specific conductance      | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | X  | X  | -  | -  | -  | -  | -  | -  | -  |
| pH                        | -         | X | - | - | - | X | X | X | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | -  | -  | X  | X  |
| Fluoride                  | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  |
| Nitrite plus nitrate      | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Nitrite                   | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Sulfate                   | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Arsenic                   | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  |
| Boron                     | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Chromium                  | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Copper                    | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  |
| Lead                      | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  |
| Mercury                   | -         | - | - | - | - | - | - | X | - | -  | X  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Selenium                  | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Vanadium                  | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Zinc                      | -         | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Phytoplankton, toxic taxa | -         | - | - | - | - | - | - | - | - | -  | X  | -  | X  | X  | X  | -  | -  | X  | X  | X  | -  | -  | -  | X  |

values larger than the criteria for the protection of livestock. Water samples from reservoir 21 were sufficiently close to the limits of both of these variables to be regarded as potentially hazardous to livestock.

Most of the reservoirs had August pH values larger than the criteria; however, the excess generally was less than 0.5 pH unit and occurred only during late summer. Large pH values in these reservoirs do not pose a great threat but could be indicative of large phytoplankton concentrations--some of which might be toxic. The long-term effects of the pH differences in this area are not known. No recent livestock deaths have been attributed to large pH values, which indicates that the existing pH values probably are not critical.

Reservoir 21 was the only reservoir having several trace-element concentrations in water large enough to be hazardous to livestock. Reservoirs 8 and 11 were the only other reservoirs with trace-element concentrations exceeding water-quality criteria for the protection of livestock. These reservoirs had large mercury concentrations, both of which exceeded the mercury criterion by 0.05 µg/L.

The two species of potentially toxic phytoplankton present in the study reservoirs were *Aphanizomenon flos-aquae* and *Coelosphaerium Kuetzingianum*. One or both of these species occurred in reservoirs 11, 13-15, 18-20, and 24. Research has not defined the particular variety nor the concentration of phytoplankton that is toxic to livestock. Consequently, it is important to monitor livestock watering at these reservoirs when phytoplankton concentrations are large.

## Recreation use

Conditions in most of the reservoirs sampled did not satisfy criteria protective of swimmers (table 11). Bacterial analyses of water from the reservoirs are

Table 11.--*Water-quality criteria for the protection of people who directly contact water by swimming*

[Abbreviations: m, meter; min, minimum; max, maximum; mL, milliliter; EPA, U.S. Environmental Protection Agency; NTAC, National Technical Advisory Committee to the Secretary of the Interior]

| Variable          | Criteria                      | Source       |
|-------------------|-------------------------------|--------------|
| Secchi-disk depth | 1.22 m, min                   | NTAC (1968). |
| pH                | 6.5-8.3, min-max              | NTAC (1968). |
| Fecal coliform    | 200 organisms per 100 mL, max | EPA (1978).  |

given in tables 12 and 13. A comparison of reservoir water quality determined by analyses to water-quality criteria for the protection of swimmers is given in table 14. No reservoir met all criteria for swimming.

Table 12.--*Bacterial analyses of water samples from 12 reservoirs in Valley County*

[<, less than; >, more than]

|                               |                   | Number of organisms per 100 milliliters in water samples from indicated reservoir |       |      |      |      |       |         |      |        |      |       |       |
|-------------------------------|-------------------|---|-------|------|------|------|-------|---------|------|--------|------|-------|-------|
| Bacteria                      | Sampling location | 1   | 2     | 3    | 4    | 5    | 6     | 7       | 8    | 9      | 10   | 11    | 12    |
| <u>May sampling period</u>    |                   |   |       |      |      |      |       |         |      |        |      |       |       |
| Total coliform                | Midpoint          | 26  | 660*  | 400  | 20*  | 47*  | 56    | 190     | 4*   | 56     | --   | --    | 70*   |
|                               | Shore             | 100   | 3,500 | 280  | 17*  | 100* | 71*   | 300     | 20*  | 19     | --   | --    | 47*   |
| Fecal coliform                | Midpoint          | <1  | 140   | 440  | 5*   | 10*  | 9*    | <5*     | 5*   | <1*    | 40*  | <1*   | 27*   |
|                               | Shore             | <1  | 130   | 270  | 37*  | 10*  | 9*    | 20*     | 5*   | 4*     | 42*  | 1*    | 20*   |
| Fecal streptococci            | Midpoint          | 10  | 130   | 120  | 13*  | 48*  | 3*    | 200*    | 13*  | 2*     | 7*   | 16    | 67    |
|                               | Shore             | 3*  | 120   | 150  | 10*  | 50*  | 20*   | 17*     | 10*  | 11*    | 100* | 94    | 480   |
| FC/FS ratio <sup>1</sup>      | Midpoint          | <.10*   | 1.1   | 3.7  | .38* | .21* | 3.0*  | <.03*   | .38* | <.50*  | 5.7* | <.06* | .40   |
|                               | Shore             | <.33*   | 1.1   | 1.8  | 2.7* | .20* | .45*  | 1.2*    | 50*  | .36*   | .42* | .01   | .04*  |
| <u>August sampling period</u> |                   |   |       |      |      |      |       |         |      |        |      |       |       |
| Total coliform                | Midpoint          | --  | 790   | 70   | 950  | 240  | 690   | 290     | 460  | 680    | 230  | 12*   | 240   |
|                               | Shore             | --  | 100   | 150  | 530  | 290  | 800   | 140     | 280  | 1,100* | 260  | 22    | 320   |
| Fecal coliform                | Midpoint          | <1*   | <5*   | 95*  | 20*  | 43*  | 4     | <10*    | 3*   | 3*     | 210  | 8*    | <5*   |
|                               | Shore             | <5*   | 5*    | 210  | 750  | 50*  | >600* | 40*     | 10*  | 3*     | 260  | 24    | <5*   |
| Fecal streptococci            | Midpoint          | 3*  | 5*    | 39*  | 10*  | 480  | 94    | 15,000* | 94   | 26     | 500  | 420   | 30*   |
|                               | Shore             | 12*   | 150   | 55*  | 150  | 680  | 150   | 600*    | 72   | 1,500  | 730  | 60    | 27*   |
| FC/FS ratio <sup>1</sup>      | Midpoint          | <.33*   | <1.0* | 2.4* | 2.0* | .09* | .04   | <.001*  | .03* | .12*   | .42  | .02*  | <.17  |
|                               | Shore             | <.42*   | .03*  | 3.8* | 5.0  | .07* | >4.0* | .07*    | .14  | .002*  | .36  | .40   | <.19* |

\*Estimated count based on nonideal colony count.

<sup>1</sup>Fecal coliform organisms per 100 milliliters divided by fecal streptococcal organisms per 100 milliliters.

Table 13.--Bacterial analyses of water samples from 12 reservoirs in Phillips County

[&lt;, less than; &gt;, more than]

| Bacteria                      | Sampling location | Number of organisms per 100 milliliters |      |      |       |       |      | In water samples from indicated reservoir |       |         |      |      |      |
|-------------------------------|-------------------|---|------|------|-------|-------|------|---|-------|---------|------|------|------|
|                               |                   | 13                                      | 14   | 15   | 16    | 17    | 18   | 19  | 20    | 21      | 22   | 23   | 24   |
| <u>May sampling period</u>    |                   |   |      |      |       |       |      |   |       |         |      |      |      |
| Total coliform                | Midpoint          | 10                                      | 540  | 84   | 2,000 | 67*   | 37   | 370                                       | 8*    | 8000    | 43   | 42   | 290  |
|                               | Shore             | 40                                      | 60   | 140  | 3,000 | 100*  | 24*  | 940*                                      | 50    | <1,000* | 79   | 280  | 300  |
| Fecal coliform                | Midpoint          | 5*                                      | 10*  | 5*   | 100*  | 20*   | 20*  | 10*                                       | 25*   | <1,000* | 1*   | <3*  | 12*  |
|                               | Shore             | <2*                                     | 9*   | 2*   | 40*   | 20*   | 10*  | 5*  | <3*   | <1,000* | 1*   | 16*  | 10*  |
| Fecal streptococci            | Midpoint          | <2*                                     | 2*   | 10*  | 100*  | 40*   | 28   | 11*                                       | 8*    | <1,000* | 6*   | <3*  | 12*  |
|                               | Shore             | <2*                                     | 10*  | 25   | 100*  | 100*  | 11   | 10*                                       | 8*    | <1,000* | 8*   | 10*  | 35   |
| FC/FS ratio <sup>1</sup>      | Midpoint          | >2.5*                                   | 5.0* | .50* | 1.0*  | .50*  | .71* | .91*                                      | 3.1*  | 1*      | .17* | 1.0* | 1.0* |
|                               | Shore             | 1.0*                                    | .90* | .08* | .40*  | .20*  | .91* | .50*                                      | <.38* | 1*      | .13* | 1.6* | .29* |
| <u>August sampling period</u> |                   |   |      |      |       |       |      |   |       |         |      |      |      |
| Total coliform                | Midpoint          | 90*                                     | 54   | 64   | <10*  | 45*   | 23*  | 67  | 270   | 200*    | 70   | 360  | 810* |
|                               | Shore             | 220                                     | 35   | 180  | <10*  | <10*  | 30*  | 90  | 900*  | <100    | 150* | 64   | 970* |
| Fecal coliform                | Midpoint          | 14*                                     | 10*  | 13*  | <10*  | <10*  | 12*  | 2*  | <2*   | 400*    | 11*  | 2*   | 20*  |
|                               | Shore             | 4*                                      | 10*  | 14*  | <10*  | <10*  | 3*   | 20*                                       | 2*    | <100*   | 5*   | 76*  | 23*  |
| Fecal streptococci            | Midpoint          | 7*                                      | 9*   | 26   | 20*   | <10*  | 11*  | 260                                       | <2*   | 1,000*  | 19   | <2*  | 30*  |
|                               | Shore             | 42                                      | 34*  | 29   | 20*   | 220   | 15*  | 33  | 8*    | 100*    | 61   | 116  | 10*  |
| FC/FS ratio <sup>1</sup>      | Midpoint          | 2.0*                                    | 1.1* | .50* | <.50* | 1.0*  | 1.1* | .01*                                      | 2.0*  | .40*    | .58* | 2.0* | .67  |
|                               | Shore             | .10*                                    | .29* | .48* | <.50* | <.05* | .20* | .61*                                      | .25*  | <1.0*   | .08* | .66* | 2.3* |

\*Estimated count based on nonideal colony count.

<sup>1</sup> Fecal coliform organisms per 100 milliliters divided by fecal streptococcal organisms per 100 milliliters.

Most of the reservoirs had Secchi-disk depths less than the criterion protective of swimmers. These results would preclude using the reservoirs for swimming.

All reservoirs except 3 and 5 had samples with pH values greater than the criteria (table 14). These large pH values occurred most often during late summer and early autumn when the waters also were the warmest for swimming.

The ratio of fecal coliform to fecal streptococcal bacteria (FC/FS) indicates that the reservoirs generally have fecal pollution from livestock and waterfowl. Fecal-coliform concentrations were greater than the criterion in reservoirs 3, 4, 6, 10, and 21 (table 14). At these reservoirs there were indications that at some time livestock had been in the area. Waterfowl also were seen in the area and could contribute to large fecal coliform concentrations.

Although only five reservoirs had fecal coliform concentrations in excess of the criterion for the protection of swimmers, other reservoirs could have excessive concentrations during times not sampled. Because these reservoirs are used for stockwatering, large concentrations of fecal coliform can be expected during the grazing months. Therefore, proper precautions are needed if these reservoirs are to be managed for swimming. Other sources of fecal coliform can result from waterfowl using the reservoirs. However, this source cannot be controlled as easily as livestock.

Table 14.--Comparison of reservoir water quality to water-quality criteria for the protection of swimmers

[X denotes water-quality variables that do not meet the criterion in at least one sample]

| Variable          | Reservoir |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------------------|-----------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                   | 1         | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Secchi-disk depth | X         | X | X | - | X | - | X | X | X | X  | -  | X  | X  | -  | X  | X  | X  | -  | X  | -  | X  | X  | X  | X  |
| pH                | X         | X | - | X | - | X | X | X | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Fecal coliform    | -         | - | X | X | - | X | - | - | - | X  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | X  | -  | -  | -  |

In addition to the pH and clarity problems in most of the reservoirs, there were also biological problems. Most reservoirs support leech populations (*Hirudinea*) and growths of submersed aquatic plants that would be a nuisance to swimmers.

#### WATER-QUALITY CHANGES IN RESPONSE TO RESERVOIR USE

Several studies have outlined the effects of livestock grazing on water quality. Increased sediment, turbidity, pathogens, and nutrients are major water-quality changes associated with livestock grazing (Moore and others, 1979). Also of major concern are the effects of livestock grazing on aquatic plants and vegetation around the reservoirs. Moore and others (1979) have outlined several best-management practices that prevent or minimize the effects of livestock on water quality. These practices include adjusting the density of livestock, fencing certain areas, and providing alternative sources of water. Information that compares livestock density to the major water-quality variables associated with grazing would enable the best management practices to be chosen to prevent increasing the natural rate of eutrophication. These practices would increase the useful life of the reservoirs in the study area.

Fish, waterfowl, and people also can affect the quality of water. Fish and waterfowl would add to the nutrient cycling in reservoirs. Use of reservoirs by waterfowl and people could increase the probability of exposure to disease through bacterial contamination of the water. Certain species of fish and waterfowl in large densities would increase the turbidity of water along the shore through foraging and other activities; turbidity in open water would result if winds circulated the turbid water from shore. Activities of people along the shore also could increase turbidity; however, increases probably would be minimal compared to long-term turbidity increases resulting from motor vehicle destruction of vegetation surrounding the reservoir. The magnitude of these effects on water quality depends on the degree of reservoir use.

Because reservoirs progress through different stages as they age, it might be more appropriate to manage the reservoirs for fish propagation and waterfowl habitat in succession, while also providing water for livestock. Newly formed reservoirs would be less stressful to fish because of less variable seasonal and diel dissolved-oxygen concentrations. As the reservoirs become more enriched with aquatic plants and phytoplankton, the seasonal and diel dissolved-oxygen concentrations will become more variable. However, the increase in aquatic plants and phytoplankton will improve the waterfowl habitat.

Final management decisions for reservoirs that have questionable water quality might best be made after a small-scale pilot program is conducted. Because different species have different tolerances that could restrict their use of certain reservoirs, more specific criteria may be required for proper management. Additional information such as reservoir location and access also may be important in management decisions for a particular reservoir.

## CONCLUSIONS

Considering the quality of water among the study reservoirs and all the water-quality criteria, reservoirs 8, 9, 11, 12, 14, and 19 generally had the best water quality for fish propagation. Because of the large nutrient concentrations in all the study reservoirs, they can be classified as eutrophic, and thus have the potential of attaining dissolved-oxygen concentrations less than the criterion protective of fish. However, if fish are harvested at a rate in balance with production, the large nutrient concentrations could provide for a productive fishery.

The water-quality criteria for the protection of waterfowl mostly pertain to protection of aquatic plants. The reservoirs studied provide varying degrees of habitat for waterfowl. Reservoirs 16, 17, and 21 supported the least waterfowl habitat. These reservoirs lacked significant numbers of emerged plants that might be used by waterfowl. Reservoirs 7-12 had pH values larger than the criteria; however, these reservoirs supported plant growth and the length of time that pH exceeded the criteria is short. Therefore, these large pH values may not be critical. Because of small dissolved-oxygen concentrations in the bottom water, proper management of waterfowl would be critical in reservoirs 1, 2, 20, and 22 if botulism were to occur. Total alkalinity in reservoir 24 was less than the criterion for the protection of aquatic plants and, therefore, waterfowl habitat. Alkalinity may increase to a more suitable value as this reservoir ages and result in additional plant growth.

Most of the reservoirs were satisfactory for livestock watering. Reservoirs 16, 17, and 21 may need to be monitored during dry years, because of large dissolved-solids concentrations. Also of concern are the potentially toxic species of phytoplankton in reservoirs 11, 13-15, 18-20, and 24.

Conditions in the reservoirs were not favorable for swimming. Visibility was less than the criterion protective of swimmers in most of the reservoirs and eye irritation from large pH values could occur in late summer and early autumn. In addition, leech populations and growths of submersed aquatic plants in most of the reservoirs would be a nuisance to swimmers.

Specific uses for certain reservoirs might require more information and specific criteria for proper management. Also small-scale pilot programs might be useful for reservoirs with questionable water quality.

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Table 15.--Taxa and numbers of phytoplankton collected from reservoirs

[m, meter; mL, milliliter; &lt;, less than]

| RESERVOIR 1--AIR BASE POND          |                 |              |                 |              |                 |              |                 |              |
|-------------------------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
| DATE:                               | 5-9-78          |              | 5-9-78          |              | 8-20-78         |              | 8-20-78         |              |
| TIME:                               | 1001            |              | 1003            |              | 0916            |              | 0918            |              |
| DEPTH:                              | 1.0 m           |              | 3.0 m           |              | 1.0 m           |              | 3.0 m           |              |
|                                     | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)           |                 | 6.20         |                 | 4.72         |                 | <43.92       |                 | 41.87        |
| Chlorophyceae                       |                 |              |                 |              |                 |              |                 |              |
| <i>Ankistrodesmus falcatus</i>      | 47              | 1.44         | 38              | 1.16         | 7,576           | 6.34         | 4,689           | 6.78         |
| <i>Chodatella quadriseta</i>        |                 |              |                 |              | 50              | .04          |                 |              |
| <i>C. spp.</i>                      |                 |              |                 |              | <1              | <.01         |                 |              |
| <i>Coelastrum microporum</i>        |                 |              |                 |              | 10,496          | 8.78         | 2,432           | 3.52         |
| <i>Cosmarium spp.</i>               |                 |              |                 |              |                 |              | <1              | <.01         |
| <i>Crucigenia apiculata</i>         |                 |              |                 |              | 1,408           | 1.18         |                 |              |
| <i>C. tetrapedia</i>                |                 |              |                 |              | 2,624           | 2.19         | 3,392           | 4.91         |
| <i>Dictyosphaerium pulchellum</i>   |                 |              |                 |              |                 |              | 5,568           | 8.06         |
| <i>D. spp.</i>                      |                 |              |                 |              | 7,264           | 6.08         |                 |              |
| <i>Elakatothrix gelatinosa</i>      |                 |              |                 |              | 682             | .57          | 228             | .33          |
| <i>Golenkinia radiata</i>           |                 |              |                 |              | 25              | .02          | <1              | <.01         |
| <i>Kirchneriella spp.</i>           |                 |              |                 |              | 7,776           | 6.50         | 2,784           | 4.03         |
| <i>Oocystis spp.</i>                |                 |              |                 |              | 2,624           | 2.19         | 1,576           | 2.28         |
| <i>Pediastrum Boryanum</i>          |                 |              |                 |              | 1,008           | .84          | <1              | <.01         |
| <i>P. duplex</i>                    |                 |              |                 |              | <1              | <.01         |                 |              |
| <i>P. tetras</i>                    | 12              | .37          |                 |              |                 |              |                 |              |
| <i>Scenedesmus abundans</i>         |                 |              | 60              | 1.83         | 352             | .29          | 1,000           | 1.45         |
| <i>S. bijuga</i>                    |                 |              |                 |              | 2,072           | 1.73         | 1,728           | 2.50         |
| <i>S. dimorphus</i>                 | 44              | 1.34         | 44              | 1.34         | 1,868           | 1.56         | 750             | 1.09         |
| <i>S. opoliensis</i>                | 92              | 2.81         |                 |              | 4,544           | 3.80         | 2,820           | 4.08         |
| <i>S. quadricauda</i>               |                 |              | 8               | .24          |                 |              |                 |              |
| <i>Tetraedron caudatum</i>          |                 |              |                 |              | 13              | .01          | 23              | .03          |
| <i>T. minimum</i>                   | 8               | .24          | 5               | .15          | 379             | .32          | 114             | .16          |
| <i>T. trigonum</i>                  |                 |              |                 |              | 13              | .01          | 23              | .03          |
| <i>Tetrastrum staurogeniaeforme</i> |                 |              |                 |              | 1,716           | 1.44         | 1,788           | 2.59         |
| <i>Treubaria setigerum</i>          |                 |              |                 |              | 13              | .01          |                 |              |
| CHRYSTOPHYTA                        |                 | .24          |                 | .94          |                 | <.25         |                 | <.40         |
| Bacillariophyceae (diatoms)         |                 |              |                 |              |                 |              |                 |              |
| <i>Cocconeis placentula</i>         |                 |              | 8               | .24          |                 |              |                 |              |
| <i>Cyclotella spp.</i>              | 3               | .09          | 14              | .43          |                 |              |                 |              |
| <i>Cymbella minuta</i>              |                 |              |                 |              | 38              | .03          |                 |              |
| <i>C. spp.</i>                      |                 |              |                 |              | <1              | <.01         | <1              | <.01         |
| <i>Diploneis spp.</i>               |                 |              |                 |              |                 |              | 23              | .03          |
| <i>Epithemia sorex</i>              | 2               | .06          |                 |              |                 |              |                 |              |
| <i>Fragilaria vaucheriae</i>        | 3               | .09          | 3               | .09          |                 |              |                 |              |
| <i>Gomphonema acuminatum</i>        |                 |              |                 |              | <1              | <.01         | <1              | <.01         |
| <i>Gyrosigma macrum</i>             |                 |              |                 |              | <1              | <.01         |                 |              |
| <i>Navicula spp.</i>                |                 |              | 3               | .09          |                 |              | 38              | .05          |
| <i>Nitzschia acicularis</i>         |                 |              |                 |              | <1              | <.01         |                 |              |
| <i>N. spp.</i>                      |                 |              |                 |              |                 |              | 174             | .25          |
| <i>Rhoicosphenia curvata</i>        |                 |              |                 |              | <1              | <.01         |                 |              |
| <i>Surirella ovalis</i>             |                 |              | 3               | .09          |                 |              |                 |              |
| <i>Synedra spp.</i>                 |                 |              |                 |              | 202             | .17          | 38              | .05          |
| CRYPTOPHYTA (cryptomonads)          |                 | 78.18        |                 | 77.90        |                 | .13          |                 |              |
| Cryptophyceae                       |                 |              |                 |              |                 |              |                 |              |
| <i>Chroomonas spp.</i>              | 2,466           | 75.37        | 2,489           | 75.77        |                 |              |                 |              |
| <i>Cryptomonas spp.</i>             | 92              | 2.81         | 70              | 2.13         | 152             | .13          |                 |              |
| CYANOPHYTA (blue-green algae)       |                 | 12.84        |                 | 15.53        |                 | 55.49        |                 | 57.51        |
| Cyanophyceae                        |                 |              |                 |              |                 |              |                 |              |
| <i>Anabaena spp.</i>                | 420             | 12.84        | 510             | 15.53        | 15,540          | 13.00        | 4,770           | 6.90         |
| <i>Aphanothece gelatinosa</i>       |                 |              |                 |              | 13,250          | 11.08        | 5,700           | 8.25         |
| <i>Gloeotheca spp.</i>              |                 |              |                 |              | 3,800           | 3.18         | 7,950           | 11.50        |
| <i>Merismopedia punctata</i>        |                 |              |                 |              | 13,136          | 10.99        | 7,520           | 10.88        |
| <i>M. tenuissima</i>                |                 |              |                 |              | 20,608          | 17.24        | 13,808          | 19.98        |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 1--AIR BASE POND--Continued |                 |              |                 |              |                 |              |                 |              |
|---------------------------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
| DATE:                                 | 5-9-78          |              | 5-9-78          |              | 8-20-78         |              | 8-20-78         |              |
| TIME:                                 | 1001            |              | 1003            |              | 0916            |              | 0918            |              |
| DEPTH:                                | 1.0 m           |              | 3.0 m           |              | 1.0 m           |              | 3.0 m           |              |
|                                       | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| EUGLENOPHYTA (euglenoids)             |                 |              |                 |              |                 | .10          |                 | .25          |
| Euglenophyceae                        |                 |              |                 |              |                 |              |                 |              |
| <i>Euglena</i> spp.                   |                 |              |                 |              | 114             | .10          | 174             | .25          |
| PYRRHOPHYTA (fire algae)              |                 | 2.54         |                 | .91          |                 | .17          |                 | <.01         |
| Dinophyceae (dinoflagellates)         |                 |              |                 |              |                 |              |                 |              |
| <i>Gymnodinium</i> spp.               |                 |              |                 |              | 202             | .17          | <1              | <.01         |
| <i>Peridinium</i> spp.                | 83              | 2.54         | 30              | .91          |                 |              |                 |              |
| Total number of cells                 | 3,272           |              | 3,285           |              | 119,552         |              | 69,116          |              |
| Total number of taxa                  | 12              |              | 14              |              | 37              |              | 31              |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 2--VADOR RESERVOIR        |                 |              |                 |              |                 |              |                 |              |
|-------------------------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
|                                     |                 |              |                 |              |                 |              |                 |              |
| DATE:                               | 5-9-78          |              | 5-9-78          |              | 8-20-78         |              | 8-20-78         |              |
| TIME:                               | 1541            |              | 1545            |              | 1331            |              | 1338            |              |
| DEPTH:                              | 1.0 m           |              | 5.0 m           |              | 0.50 m          |              | 4.0 m           |              |
|                                     | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)           |                 | 23.67        |                 | 17.86        |                 | 76.80        |                 | 48.03        |
| Chlorophyceae                       |                 |              |                 |              |                 |              |                 |              |
| <i>Ankistrodesmus falcatus</i>      | 32              | .85          | 107             | .71          | 883             | 1.16         | 318             | .47          |
| <i>Chodatella quadriseta</i>        |                 |              |                 |              | 25              | .03          |                 |              |
| <i>Coleastrum microporum</i>        | 832             | 22.20        | 2,560           | 17.05        | 13,728          | 17.98        | 8,256           | 12.29        |
| <i>Cosmarium formosulum</i>         | 13              | .35          |                 |              |                 |              |                 |              |
| <i>C. spp.</i>                      |                 |              | 7               | .05          |                 |              | 15              | .02          |
| <i>Crucigenia tetrapedia</i>        |                 |              |                 |              |                 |              | 368             | .55          |
| <i>Dictyosphaerium spp.</i>         |                 |              |                 |              | 3,632           | 4.76         |                 |              |
| <i>Euastrum pectinatum</i>          |                 |              |                 |              |                 |              | 23              | .03          |
| <i>Golenkinia radiata</i>           |                 |              |                 |              | 25              | .03          | 15              | .02          |
| <i>Kirchneriella lunaris</i>        |                 |              |                 |              | 6,872           | 9.00         |                 |              |
| <i>K. obesa</i>                     |                 |              |                 |              | 4,240           | 5.55         |                 |              |
| <i>Oocystis spp.</i>                |                 |              |                 |              | 19,592          | 25.66        | 17,216          | 25.62        |
| <i>Pediastrum Boryanum</i>          |                 |              |                 |              | 800             | 1.05         | 608             | .90          |
| <i>Scenedesmus abundans</i>         |                 |              |                 |              | 2,628           | 3.44         | 788             | 1.17         |
| <i>S. bijuga</i>                    |                 |              |                 |              | 3,736           | 4.89         | 3,152           | 4.69         |
| <i>S. dimorphus</i>                 |                 |              |                 |              | 304             | .40          | 1,032           | 1.54         |
| <i>S. quadricauda</i>               |                 |              |                 |              | 908             | 1.19         |                 |              |
| <i>S. spp.</i>                      | 10              | .27          |                 |              |                 |              |                 |              |
| <i>Tetraedron caudatum</i>          |                 |              |                 |              | 126             | .17          |                 |              |
| <i>T. minimum</i>                   |                 |              | 7               | .05          | 606             | .79          | 432             | .64          |
| <i>T. trigonum</i>                  |                 |              |                 |              | 76              | .10          | 39              | .06          |
| <i>Tetrastrum staurogeniaeforme</i> |                 |              |                 |              | 404             | .53          |                 |              |
| <i>Treubaria setigerum</i>          |                 |              |                 |              | 50              | .07          | 23              | .03          |
| CHRYSTOPHYTA                        |                 | 67.38        |                 | 71.12        |                 | <.91         |                 | <.80         |
| Bacillariophyceae (diatoms)         |                 |              |                 |              |                 |              |                 |              |
| <i>Amphiprora paludosa</i>          |                 |              | 33              | .22          |                 |              |                 |              |
| <i>Asterionella formosa</i>         |                 |              |                 |              |                 |              | <1              | <.01         |
| <i>Cocconeis placentula</i>         | 38              | 1.01         |                 |              | <1              | <.01         |                 |              |
| <i>Cyclotella spp.</i>              | 2,487           | 66.37        | 10,540          | 70.19        | 25              | .03          |                 |              |
| <i>Melosira distans</i>             |                 |              |                 |              | 227             | .30          | 409             | .61          |
| <i>M. granulata</i>                 |                 |              | 73              | .49          |                 |              |                 |              |
| <i>Nitzschia filiformes</i>         |                 |              |                 |              | 50              | .07          |                 |              |
| <i>N. spp.</i>                      |                 |              | 33              | .22          |                 |              | 121             | .18          |
| <i>Synedra spp.</i>                 |                 |              |                 |              | 379             | .50          |                 |              |
| CRYPTOPHYTA (cryptomonads)          |                 | 6.54         |                 | 9.32         |                 |              |                 |              |
| Cryptophyceae                       |                 |              |                 |              |                 |              |                 |              |
| <i>Chroomonas spp.</i>              | 200             | 5.34         | 1,000           | 6.66         |                 |              |                 |              |
| <i>Cryptomonas spp.</i>             | 45              | 1.20         | 400             | 2.66         |                 |              |                 |              |
| CYANOPHYTA (blue-green algae)       |                 | 2.40         |                 | 1.40         |                 | 22.32        |                 | 51.16        |
| Cyanophyceae                        |                 |              |                 |              |                 |              |                 |              |
| <i>Anabaena spp.</i>                | 90              | 2.40         | 210             | 1.40         | 6,810           | 8.92         | 31,830          | 47.37        |
| <i>Aphanothece gelatinosa</i>       |                 |              |                 |              | 2,500           | 3.27         |                 |              |
| <i>Merismopedia tenuissima</i>      |                 |              |                 |              | 7,680           | 10.06        | 2,544           | 3.79         |
| <i>Synechocystis spp.</i>           |                 |              |                 |              | 50              | .07          |                 |              |
| EUGLENOPHYTA (euglenoids)           |                 |              |                 | .31          |                 |              |                 |              |
| Euglenophyceae                      |                 |              |                 |              |                 |              |                 |              |
| <i>Trachelomonas spp.</i>           |                 |              | 47              | .31          |                 |              |                 |              |
| Total number of cells               | 3,747           |              | 15,017          |              | 76,363          |              | 67,190          |              |
| Total number of taxa                | 9               |              | 12              |              | 27              |              | 19              |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs---Continued

|                                   | RESERVOIR 3--VR-82 |              |                 |              |                 |              | RESERVOIR 4--VR-77 |              |                 |              |
|-----------------------------------|--------------------|--------------|-----------------|--------------|-----------------|--------------|--------------------|--------------|-----------------|--------------|
|                                   | 5-10-78            |              | 5-10-78         |              | 8-21-78         |              | 5-10-78            |              | 8-21-78         |              |
|                                   | 0816               |              | 0818            |              | 0946            |              | 1426               |              | 1331            |              |
|                                   | 1.0 m              |              | 3.0 m           |              | 1.0 m           |              | 1.0 m              |              | 1.0 m           |              |
|                                   | Cells<br>per mL    | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL    | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)         |                    | 46.23        |                 | 28.86        |                 | <51.28       |                    | 20.56        |                 | 14.41        |
| Chlorophyceae                     |                    |              |                 |              |                 |              |                    |              |                 |              |
| <i>Ankistrodesmus falcatus</i>    | 89                 | 13.84        | 500             | 10.46        | 2,045           | 17.05        | 1,733              | 12.39        |                 |              |
| <i>Closterium</i> spp.            |                    |              |                 |              |                 |              | 17                 | .12          |                 |              |
| <i>Cosmarium</i> spp.             |                    |              |                 |              | 8               | .07          | 17                 | .12          |                 |              |
| <i>Dictyosphaerium pulchellum</i> |                    |              |                 |              | 544             | 4.54         |                    |              |                 |              |
| <i>Dimorphococcus lunatus</i>     | 1,248              | 19.43        | 704             | 14.72        |                 |              | 272                | 1.94         |                 |              |
| <i>Golenkinia radiata</i>         | 11                 | .17          |                 |              |                 |              | 100                | .72          |                 |              |
| <i>Oocystis</i> spp.              |                    |              |                 |              |                 |              |                    |              | 72              | 4.97         |
| <i>Pediastrum Boryanum</i>        |                    |              |                 |              | 544             | 4.54         |                    |              | 64              | 4.41         |
| <i>P. duplex</i>                  |                    |              |                 |              | < 1             | <.01         |                    |              |                 |              |
| <i>Scenedesmus abundans</i>       |                    |              |                 |              | 1,312           | 10.94        |                    |              |                 |              |
| <i>S. dimorphus</i>               | 132                | 2.05         | 132             | 2.76         | 372             | 3.10         | 468                | 3.35         |                 |              |
| <i>S. opoliensis</i>              |                    |              |                 |              | 908             | 7.57         | 200                | 1.43         |                 |              |
| <i>S. quadricauda</i>             |                    |              | 44              | .92          |                 |              |                    |              |                 |              |
| <i>S. spp.</i>                    | 224                | 3.49         |                 |              |                 |              |                    |              | 8               | .55          |
| <i>Schroederia Judayi</i>         |                    |              |                 |              |                 |              |                    |              | 35              | 2.41         |
| <i>S. setigera</i>                |                    |              |                 |              | 101             | .84          |                    |              |                 |              |
| <i>Selenastrum minutum</i>        |                    |              |                 |              | 244             | 2.03         |                    |              |                 |              |
| <i>Staurostrum</i> spp.           |                    |              |                 |              | < 1             | <.01         |                    |              |                 |              |
| <i>Tetraedron caudatum</i>        |                    |              |                 |              | 8               | .07          |                    |              |                 |              |
| <i>T. minimum</i>                 | 33                 | .51          |                 |              | 17              | .14          |                    |              | 30              | 2.07         |
| <i>T. pentaedricum</i>            | 33                 | .51          |                 |              |                 |              |                    |              |                 |              |
| <i>Tetrastrum</i>                 | 400                | 6.23         |                 |              | 32              | .27          | 68                 | .49          |                 |              |
| <i>staurogeniaeforme</i>          |                    |              |                 |              |                 |              |                    |              |                 |              |
| <i>Treubaria setigerum</i>        |                    |              |                 |              | 34              | .28          |                    |              |                 |              |
| CHRYSTOPHYTA                      |                    | 32.04        |                 | 47.18        |                 | <5.01        |                    | 21.45        |                 | 3.11         |
| Bacillariophyceae (diatoms)       |                    |              |                 |              |                 |              |                    |              |                 |              |
| <i>Cocconeis placentula</i>       |                    |              |                 |              | 8               | .07          | 150                | 1.07         | 43              | 2.97         |
| <i>Cyclotella</i> spp.            | 56                 | .87          | 733             | 15.33        | < 1             | <.01         |                    |              |                 |              |
| <i>Cymbella</i> spp.              |                    |              |                 |              | 17              | .14          |                    |              | 2               | .14          |
| <i>Fragilaria crotonensis</i>     | 111                | 1.73         |                 |              |                 |              |                    |              |                 |              |
| <i>F. vaucheriae</i>              | 767                | 11.98        | 656             | 13.72        |                 |              |                    |              |                 |              |
| <i>Navicula</i> spp.              |                    |              |                 |              | 17              | .14          |                    |              |                 |              |
| <i>Nitzschia acicularis</i>       | 622                | 9.68         | 867             | 18.13        | 217             | 1.81         |                    |              |                 |              |
| <i>N. spp.</i>                    |                    |              |                 |              | < 1             | <.01         |                    |              |                 |              |
| <i>Stephanodiscus astrea</i>      | 500                | 7.78         |                 |              |                 |              | 2,633              | 18.83        |                 |              |
| <i>Synedra ulna</i>               |                    |              |                 |              |                 |              | 217                | 1.55         |                 |              |
| <i>S. spp.</i>                    |                    |              |                 |              | 84              | .70          |                    |              |                 |              |
| <i>Uroglena</i> spp.              |                    |              |                 |              | 256             | 2.13         |                    |              |                 |              |
| CRYPTOPHYTA (cryptomonads)        |                    | 1.21         |                 | 3.26         |                 | 12.78        |                    |              |                 | 55.59        |
| Cryptophyceae                     |                    |              |                 |              |                 |              |                    |              |                 |              |
| <i>Chroomonas</i> spp.            |                    |              |                 |              |                 |              |                    |              | 178             | 12.28        |
| <i>Cryptomonas</i> spp.           | 78                 | 1.21         | 156             | 3.26         | 1,532           | 12.78        |                    |              | 628             | 43.31        |
| CYANOPHYTA (blue-green algae)     |                    | 20.55        |                 | 20.70        |                 | 30.61        |                    | 57.28        |                 | 26.90        |
| Cyanophyceae                      |                    |              |                 |              |                 |              |                    |              |                 |              |
| <i>Anabaena</i> spp.              | 1,320              | 20.55        | 990             | 20.70        | 3,270           | 27.27        | 8,010              | 57.28        | 390             | 26.90        |
| <i>Merismopedia tenuissima</i>    |                    |              |                 |              | 400             | 3.34         |                    |              |                 |              |
| EUGLENOPHYTA (euglenoids)         |                    |              |                 |              |                 | .14          |                    | .48          |                 |              |
| Euglenophyceae                    |                    |              |                 |              |                 |              |                    |              |                 |              |
| <i>Euglena</i> spp.               |                    |              |                 |              | 17              | .14          | 67                 | .48          |                 |              |
| PYRRHOPHYTA (fire algae)          |                    |              |                 |              |                 |              |                    | .24          |                 |              |
| Dinophyceae (dinoflagellates)     |                    |              |                 |              |                 |              |                    |              |                 |              |
| <i>Peridinium</i> spp.            |                    |              |                 |              |                 |              | 33                 | .24          |                 |              |
| Total number of cells             | 6,424              |              | 4,782           |              | 11,991          |              | 13,985             |              | 1,450           |              |
| Total number of taxa              | 15                 |              | 9               |              | 27              |              | 14                 |              | 10              |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

|                                      | RESERVOIR 6--ICH PAIR RESERVOIR |              |                 |              |                 |              | RESERVOIR 7--NEAR JOHN ARNOLD RANCH |              |                 |              |                 |              |
|--------------------------------------|---------------------------------|--------------|-----------------|--------------|-----------------|--------------|-------------------------------------|--------------|-----------------|--------------|-----------------|--------------|
|                                      | DATE: 5-11-78                   |              | 8-22-78         |              | 5-11-78         |              | 5-11-78                             |              | 8-22-78         |              | 8-22-78         |              |
|                                      | TIME: 1701                      |              | 1531            |              | 1001            |              | 1003                                |              | 0931            |              | 0935            |              |
|                                      | DEPTH: 1.0 m                    |              | 0.50 m          |              | 1.0 m           |              | 3.3 m                               |              | 0.50 m          |              | 2.5 m           |              |
|                                      | Cells<br>per mL                 | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL                     | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)            |                                 | 47.35        |                 | 18.87        |                 | 7.49         |                                     | 5.00         |                 | <6.33        |                 | 6.05         |
| Chlorophyceae                        |                                 |              |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Actinastrum hantzschii</i>        | 464                             | 12.63        |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Ankistrodesmus falcatus</i>       | 563                             | 15.33        |                 |              | 9               | .51          | 11                                  | .34          | 8               | .38          |                 |              |
| <i>Characium</i> spp.                |                                 |              | 5               | .21          |                 |              |                                     |              |                 |              |                 |              |
| <i>Coelastrum microporum</i>         |                                 |              | 320             | 13.33        | 64              | 3.63         | 64                                  | 1.96         | 64              | 3.04         |                 |              |
| <i>Dicellula</i> spp.                | 214                             | 5.83         |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Dimorphococcus lunatus</i>        | 96                              | 2.61         |                 |              |                 |              | 48                                  | 1.47         |                 |              |                 |              |
| <i>Echinospaerella limnetica</i>     | 3                               | .08          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Gloeocystis</i> spp.              |                                 |              | 64              | 2.67         |                 |              |                                     |              |                 |              |                 |              |
| <i>Oocystis</i> spp.                 | 48                              | 1.31         |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Pediastrum boryanum</i>           |                                 |              | 32              | 1.33         |                 |              |                                     |              |                 |              |                 |              |
| <i>P. duplex</i>                     | 48                              | 1.31         |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Scenedesmus abundans</i>          | 24                              | .65          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>S. bijuga</i>                     |                                 |              |                 |              |                 |              |                                     |              | 20              | .95          |                 |              |
| <i>S. dimorphus</i>                  |                                 |              |                 |              |                 |              |                                     |              | 12              | .57          |                 |              |
| <i>S. opoliensis</i>                 |                                 |              |                 |              |                 |              |                                     |              | 8               | .38          |                 |              |
| <i>S. spp.</i>                       | 144                             | 3.92         |                 |              | 16              | .91          | 32                                  | .98          |                 |              |                 |              |
| <i>Schroederia judayi</i>            |                                 |              |                 |              |                 |              |                                     |              |                 |              | 27              | 6.05         |
| <i>S. setigera</i>                   |                                 |              |                 |              |                 |              |                                     |              | 17              | .81          |                 |              |
| <i>Sphaerocystis schroeteri</i>      |                                 |              | 32              | 1.33         | 32              | 1.82         |                                     |              |                 |              |                 |              |
| <i>Tetraedon minimum</i>             |                                 |              |                 |              | 2               | .11          |                                     |              | < 1             | <.05         |                 |              |
| <i>T. pentaedricum</i>               | 23                              | .63          |                 |              | 9               | .51          | 8                                   | .25          |                 |              |                 |              |
| <i>T. trigonum</i>                   |                                 |              |                 |              |                 |              |                                     |              | 2               | .10          |                 |              |
| <i>Tetrastrum staurogeniaeforme</i>  | 76                              | 2.07         |                 |              |                 |              |                                     |              | < 1             | <.05         |                 |              |
| <i>Treubaria setigerum</i>           | 13                              | .35          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Westella</i> spp.                 | 23                              | .63          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| CHRYSTOPHYTA                         |                                 | 8.93         |                 | <6.17        |                 | 47.31        |                                     | 25.46        |                 | <.68         |                 | 6.72         |
| Bacillariophyceae (diatoms)          |                                 |              |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Cocconeis placentula</i>          | 62                              | 1.69         | 119             | 4.96         |                 |              |                                     |              | 8               | .38          | 15              | 3.36         |
| <i>Cymbella</i> spp.                 |                                 |              | < 1             | <.04         |                 |              |                                     |              |                 |              |                 |              |
| <i>Navicula</i> spp.                 |                                 |              | 10              | .42          |                 |              |                                     |              | < 1             | <.05         |                 |              |
| <i>Nitzschia acicularis</i>          |                                 |              |                 |              | 245             | 13.90        | 252                                 | 7.74         |                 |              |                 |              |
| <i>N. palea</i>                      | 36                              | .98          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>N. tryblionella</i>               | 6                               | .16          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>N. spp.</i>                       |                                 |              | 13              | .54          |                 |              |                                     |              | 5               | .24          |                 |              |
| <i>Pinnularia mesolepta</i>          |                                 |              | 2               | .08          |                 |              |                                     |              |                 |              |                 |              |
| <i>Stephanodiscus astrea</i>         | 224                             | 6.10         |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Synedra</i> spp.                  |                                 |              | 3               | .13          |                 |              |                                     |              |                 |              | 15              | 3.36         |
| Chrysophyceae (yellow - brown algae) |                                 |              |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Bicoeca</i> spp.                  |                                 |              |                 |              | 8               | .45          |                                     |              |                 |              |                 |              |
| <i>Mallomonas</i> spp.               |                                 |              |                 |              | 581             | 32.96        | 577                                 | 17.72        |                 |              |                 |              |
| CRYPTOPHYTA (cryptomonads)           |                                 | .27          |                 | 18.58        |                 | 35.00        |                                     | 19.19        |                 | 3.00         |                 | 86.10        |
| Cryptophyceae                        |                                 |              |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Chroomonas</i> spp.               |                                 |              | 444             | 18.50        | 523             | 29.67        | 541                                 | 16.61        | 50              | 2.38         | 367             | 82.29        |
| <i>Cryptomonas</i> spp.              | 10                              | .27          | 2               | .08          | 94              | 5.33         | 84                                  | 2.58         | 13              | .62          | 17              | 3.81         |
| CYANOPHYTA (blue-green algae)        |                                 | 42.47        |                 | 56.38        |                 | 10.21        |                                     | 50.35        |                 | 90.03        |                 | 1.12         |
| Cyanophyceae                         |                                 |              |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Anabaena</i> spp.                 | 1,560                           | 42.47        |                 |              | 180             | 10.21        | 1,440                               | 44.21        | 1,500           | 71.26        |                 |              |
| <i>Aphanocapsa</i> spp.              |                                 |              |                 |              |                 |              |                                     |              | 300             | 14.25        |                 |              |
| <i>Dactylococcopsis smithii</i>      |                                 |              |                 |              |                 |              |                                     |              | 2               | .10          |                 |              |
| <i>Merismopedia tenuissima</i>       |                                 |              |                 |              |                 |              |                                     |              | 80              | 3.80         |                 |              |
| <i>Microcystis</i> spp.              |                                 |              |                 |              |                 |              | 200                                 | 6.14         |                 |              |                 |              |
| <i>Nostoc</i> spp.                   |                                 |              | 1,350           | 56.25        |                 |              |                                     |              |                 |              |                 |              |
| <i>Spirulina</i> spp.                |                                 |              | 3               | .13          |                 |              |                                     |              | 13              | .62          | 5               | 1.12         |
| PYRRHOPHYTA (fire algae)             |                                 | .98          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| Dinophyceae (dinoflagellates)        |                                 |              |                 |              |                 |              |                                     |              |                 |              |                 |              |
| <i>Gymnodinium</i> spp.              | 36                              | .98          |                 |              |                 |              |                                     |              |                 |              |                 |              |
| Total number of cells                | 3,673                           |              | 2,400           |              | 1,763           |              | 3,257                               |              | 2,105           |              | 446             |              |
| Total number of taxa                 | 20                              |              | 15              |              | 12              |              | 11                                  |              | 19              |              | 6               |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 8--NEAR EAST FORK WILLOW CREEK |                 |              |                 |              |                 |              |                 |              |
|--|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
|  | DATE: 5-12-78   |              | 5-12-78         |              | 8-24-78         |              | 8-24-78         |              |
|  | TIME: 0631      |              | 0634            |              | 0947            |              | 0951            |              |
|  | DEPTH: 1.0 m    |              | 4.0 m           |              | 1.0 m           |              | 3.0 m           |              |
|  | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)                |                 | 12.49        |                 | 6.50         |                 | 2.94         |                 | 6.61         |
| Chlorophyceae                            |                 |              |                 |              |                 |              |                 |              |
| <i>Actinastrum Hantzschii</i>            | 168             | 6.86         | 32              | 2.34         |                 |              |                 |              |
| <i>Ankistrodesmus falcatus</i>           | 18              | .73          | 13              | .95          |                 |              |                 |              |
| <i>Characium</i> spp.                    |                 |              |                 |              | 2               | .03          |                 |              |
| <i>Coelastrum microporum</i>             |                 |              |                 |              | 96              | 1.30         | 480             | 6.30         |
| <i>Dictyosphaerium</i> spp.              |                 |              |                 |              | 16              | .22          |                 |              |
| <i>Eudorina elegans</i>                  | 96              | 3.92         |                 |              |                 |              |                 |              |
| <i>Oocystis</i> spp.                     |                 |              |                 |              | 56              | .76          |                 |              |
| <i>Scenedesmus abundans</i>              |                 |              |                 |              | 8               | .11          | 4               | .05          |
| <i>S. armatus</i>                        |                 |              |                 |              | 4               | .05          |                 |              |
| <i>S. bijuga</i>                         |                 |              |                 |              | 20              | .27          | 8               | .10          |
| <i>S. dimorphus</i>                      | 24              | .98          | 16              | 1.17         |                 |              |                 |              |
| <i>S. spp.</i>                           |                 |              | 28              | 2.04         |                 |              |                 |              |
| <i>Schroederia setigera</i>              |                 |              |                 |              | 15              | .20          | 12              | .16          |
| CHRYSOPHYTA                              |                 | 52.14        |                 | 51.61        |                 | <.08         |                 | .14          |
| Bacillariophyceae (diatoms)              |                 |              |                 |              |                 |              |                 |              |
| <i>Cocconeis placentula</i>              |                 |              |                 |              | 2               | .03          | 4               | .05          |
| <i>Cyclotella</i> spp.                   | 694             | 28.34        | 324             | 23.65        | < 1             | <.01         | 2               | .03          |
| <i>Cymbella</i> spp.                     |                 |              |                 |              | 2               | .03          |                 |              |
| <i>Nitzschia acicularis</i>              | 3               | .12          | 9               | .66          |                 |              |                 |              |
| <i>Rhoicosphenia curvata</i>             |                 |              |                 |              | 1               | .01          | 2               | .03          |
| <i>Stephanodiscus astrea</i>             | 162             | 6.61         | 139             | 10.15        |                 |              |                 |              |
| <i>S. spp.</i>                           | 418             | 17.07        | 235             | 17.15        |                 |              |                 |              |
| CRYPTOPHYTA (cryptomonads)               |                 | .98          |                 | 1.46         |                 | 1.41         |                 | .12          |
| Cryptophyceae                            |                 |              |                 |              |                 |              |                 |              |
| <i>Cryptomonas</i> spp.                  | 24              | .98          | 20              | 1.46         | 104             | 1.41         | 9               | .12          |
| CYANOPHYTA (blue-green algae)            |                 | 25.72        |                 | 24.09        |                 | 95.56        |                 | <93.04       |
| Cyanophyceae                             |                 |              |                 |              |                 |              |                 |              |
| <i>Anabaena Felisii</i>                  |                 |              |                 |              | 6,930           | 93.98        | 7,020           | 92.07        |
| <i>A. spp.</i>                           | 630             | 25.72        | 330             | 24.09        | 60              | .81          | 30              | .39          |
| <i>Aphanothece gelatinosa</i>            |                 |              |                 |              | 50              | .68          | 50              | .66          |
| <i>Dactylococcopsis Smithii</i>          |                 |              |                 |              | 7               | .09          | 1               | .01          |
| <i>Merismopedia punctata</i>             |                 |              |                 |              |                 |              | < 1             | <.01         |
| EUGLENOPHYTA (euglenoids)                |                 | 8.66         |                 | 16.35        |                 |              |                 |              |
| Euglenophyceae                           |                 |              |                 |              |                 |              |                 |              |
| <i>Euglena</i> spp.                      | 212             | 8.66         | 217             | 15.84        |                 |              |                 |              |
| <i>Trachelomonas</i> spp.                |                 |              | 7               | .51          |                 |              |                 |              |
| Total number of cells                    | 2,449           |              | 1,370           |              | 7,374           |              | 7,625           |              |
| Total number of taxa                     | 11              |              | 12              |              | 17              |              | 14              |              |



Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 9--GAY RESERVOIR     |                 |              |                 |              |                 |              |                 |              |
|--------------------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
| DATE:                          | 5-13-78         |              | 5-13-78         |              | 8-23-78         |              | 8-23-78         |              |
| TIME:                          | 0901            |              | 0904            |              | 1432            |              | 1438            |              |
| DEPTH:                         | 1.0 m           |              | 4.0 m           |              | 1.0 m           |              | 4.0 m           |              |
|                                | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)      |                 | 44.30        |                 | 38.94        |                 | 34.17        |                 | <12.46       |
| Chlorophyceae                  |                 |              |                 |              |                 |              |                 |              |
| <i>Ankistrodesmus falcatus</i> | 875             | 44.30        | 1,127           | 38.94        | 14              | 3.86         | 11              | 1.28         |
| <i>Coelastrum microporum</i>   |                 |              |                 |              | 32              | 8.82         |                 |              |
| <i>Cosmarium formosulum</i>    |                 |              |                 |              |                 |              | 2               | .23          |
| <i>C. spp.</i>                 |                 |              |                 |              | 1               | .28          |                 |              |
| <i>Oocystis spp.</i>           |                 |              |                 |              | 56              | 15.43        | 64              | 7.45         |
| <i>Scenedesmus bijuga</i>      |                 |              |                 |              | 4               | 1.10         | 8               | .93          |
| <i>S. quadricauda</i>          |                 |              |                 |              |                 |              | 12              | 1.40         |
| <i>S. spp.</i>                 |                 |              |                 |              | 4               | 1.10         |                 |              |
| <i>Schroederia setigera</i>    |                 |              |                 |              | 11              | 3.03         | 9               | 1.05         |
| <i>Tetraedron minimum</i>      |                 |              |                 |              | 2               | .55          | < 1             | <.12         |
| CHRYSTOPHYTA                   |                 | 45.87        |                 | 48.82        |                 | 3.86         |                 | 2.68         |
| Bacillariophyceae (diatoms)    |                 |              |                 |              |                 |              |                 |              |
| <i>Cocconeis placentula</i>    |                 |              |                 |              | 3               | .83          |                 |              |
| <i>C. spp.</i>                 |                 |              |                 |              |                 |              | 5               | .58          |
| <i>Diploneis subovalis</i>     |                 |              |                 |              |                 |              | 1               | .12          |
| <i>Eunotia spp.</i>            |                 |              |                 |              | 1               | .28          |                 |              |
| <i>Gyrosigma macrum</i>        |                 |              |                 |              |                 |              | 1               | .12          |
| <i>G. spp.</i>                 |                 |              |                 |              |                 |              | 5               | .58          |
| <i>Nitzschia acicularis</i>    | 631             | 31.95        | 853             | 29.47        |                 |              |                 |              |
| <i>N. filiformes</i>           |                 |              |                 |              | 2               | .55          |                 |              |
| <i>N. tryblionella</i>         |                 |              |                 |              |                 |              | 5               | .58          |
| <i>Stephanodiscus spp.</i>     | 275             | 13.92        | 560             | 19.35        |                 |              |                 |              |
| <i>Synedra spp.</i>            |                 |              |                 |              | 8               | 2.20         | 6               | .70          |
| CRYPTOPHYTA (cryptomonads)     |                 | 9.82         |                 | 11.75        |                 | 51.52        |                 | 49.12        |
| Cryptophyceae                  |                 |              |                 |              |                 |              |                 |              |
| <i>Chroomonas spp.</i>         |                 |              |                 |              | 102             | 28.10        | 242             | 28.17        |
| <i>Cryptomonas spp.</i>        | 194             | 9.82         | 340             | 11.75        | 85              | 23.42        | 180             | 20.95        |
| CYANOPHYTA (blue-green algae)  |                 |              |                 |              |                 | 10.46        |                 | 31.43        |
| Cyanophyceae                   |                 |              |                 |              |                 |              |                 |              |
| <i>Anabaena spp.</i>           |                 |              |                 |              | 30              | 8.26         | 270             | 31.43        |
| <i>Spirulina spp.</i>          |                 |              |                 |              | 8               | 2.20         |                 |              |
| EUGLENOPHYTA (euglenoids)      |                 |              |                 | .24          |                 |              |                 | 4.19         |
| Euglenophyceae                 |                 |              |                 |              |                 |              |                 |              |
| <i>Euglena spp.</i>            |                 |              | 7               | .24          |                 |              |                 |              |
| <i>Trachelomonas spp.</i>      |                 |              |                 |              |                 |              | 36              | 4.19         |
| PYRRHOPHYTA (fire algae)       |                 |              |                 | .24          |                 |              |                 | .12          |
| Dinophyceae (dinoflagellates)  |                 |              |                 |              |                 |              |                 |              |
| <i>Peridinium spp.</i>         |                 |              | 7               | .24          |                 |              | 1               | .12          |
| Total number of cells          | 1,975           |              | 2,894           |              | 363             |              | 859             |              |
| Total number of taxa           | 4               |              | 6               |              | 16              |              | 18              |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

|                                      | RESERVOIR 10--VR-64 |                 |              |     | RESERVOIR 11--HOSE RESERVOIR |              |                 |              |                 |              |                 |              |
|--------------------------------------|---------------------|-----------------|--------------|-----|------------------------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
|                                      | DATE:               | 8-23-78         |              |     | 5-13-78                      |              | 5-13-78         |              | 8-24-78         |              | 8-24-78         |              |
|                                      | TIME:               | 0916            |              |     | 1431                         |              | 1436            |              | 1317            |              | 1323            |              |
|                                      | DEPTH:              | 0.50 m          |              |     | 1.0 m                        |              | 6.0 m           |              | 1.0 m           |              | 1.0 m           |              |
|                                      |                     | Cells<br>per mL | Per-<br>cent |     | Cells<br>per mL              | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)            |                     |                 | 8.44         |     | 18.55                        |              | 32.17           |              | <16.61          |              | <19.84          |              |
| Chlorophyceae                        |                     |                 |              |     |                              |              |                 |              |                 |              |                 |              |
| Ankistrodesmus falcatus              |                     |                 |              | 21  | 2.93                         | 92           | 32.17           | 15           | .05             | 38           | .22             |              |
| Chodatella spp.                      |                     |                 |              |     |                              |              |                 | 40           | .15             | 30           | .17             |              |
| Coelastrum microporum                |                     |                 |              |     |                              |              |                 | 640          | 2.34            |              |                 |              |
| Cosmarium spp.                       |                     |                 |              |     |                              |              |                 | 10           | .04             |              |                 |              |
| Cosmoecidium spp.                    |                     |                 |              |     |                              |              |                 | 400          | 1.46            | 176          | 1.02            |              |
| Dictyosphaerium spp.                 |                     |                 |              |     |                              |              |                 |              |                 | 128          | .74             |              |
| Euastrum pectinatum                  |                     |                 |              |     |                              |              |                 | < 1          | <.01            |              |                 |              |
| E. pinnatum                          |                     |                 |              |     |                              |              |                 |              |                 | < 1          | <.01            |              |
| Golenkinia radiata                   |                     |                 |              |     |                              |              |                 |              |                 | 91           | .53             |              |
| Oedogonium spp.                      | 1                   | .32             |              |     |                              |              |                 |              |                 |              |                 |              |
| Oocystis spp.                        |                     |                 |              | 24  | 3.35                         |              |                 | 1,496        | 5.48            | 512          | 2.96            |              |
| Pediastrum Boryanum                  |                     |                 |              |     |                              |              |                 | < 1          | <.01            | 176          | 1.02            |              |
| P. duplex                            |                     |                 |              |     |                              |              |                 | < 1          | <.01            |              |                 |              |
| Scenedesmus abundans                 |                     |                 |              |     |                              |              |                 |              |                 | 32           | .18             |              |
| S. bijuga                            |                     |                 |              |     |                              |              |                 | 20           | .07             | 32           | .18             |              |
| S. dimorphus                         |                     |                 |              |     |                              |              |                 | 40           | .15             | 16           | .09             |              |
| S. opoliensis                        |                     |                 |              | 40  | 5.58                         |              |                 | 1,476        | 5.40            | 1,044        | 6.03            |              |
| S. serratus                          |                     |                 |              |     |                              |              |                 | 160          | .59             | 1,016        | 5.86            |              |
| S. spp.                              | 8                   | 2.60            |              |     |                              |              |                 |              |                 |              |                 |              |
| Schroederia setigera                 | 17                  | 5.52            |              |     |                              |              |                 | 20           | .07             | 23           | .13             |              |
| Sphaerocystis Schroeteri             |                     |                 |              | 48  | 6.69                         |              |                 |              |                 |              |                 |              |
| Tetraedron minimum                   |                     |                 |              |     |                              |              |                 | 167          | .61             | 102          | .59             |              |
| Tetrastrum staurogeniaeforme         |                     |                 |              |     |                              |              |                 | 40           | .15             | 16           | .09             |              |
| Treubaria setigerum                  |                     |                 |              |     |                              |              |                 | 5            | .02             | 4            | .02             |              |
| CHRYSTOPHYTA                         |                     |                 |              | .98 |                              | 59.45        |                 |              | <.12            |              | <.52            |              |
| Bacillariophyceae (diatoms)          |                     |                 |              |     |                              |              |                 |              |                 |              |                 |              |
| Cocconeis placentula                 |                     |                 |              |     |                              |              |                 | < 1          | <.01            | < 1          | <.01            |              |
| Cyclotella spp.                      |                     |                 |              |     |                              | 12           | 4.20            |              |                 |              |                 |              |
| Cymbella spp.                        |                     |                 |              |     |                              |              |                 | 5            | .02             | < 1          | <.01            |              |
| Fragilaria crotonensis               |                     |                 |              |     |                              |              |                 | 10           | .04             |              |                 |              |
| F. vaucheriae                        |                     |                 |              |     |                              | 119          | 41.61           |              |                 |              |                 |              |
| Nitzschia acicularis                 |                     |                 |              | 5   | .70                          | 36           | 12.59           |              |                 |              |                 |              |
| N. spp.                              |                     |                 |              |     |                              | 3            | 1.05            | 5            | .02             |              |                 |              |
| Synedra spp.                         |                     |                 |              |     |                              |              |                 |              |                 | 4            | .02             |              |
| Tetracyclus rupestris                |                     |                 |              |     |                              |              |                 | < 1          | <.01            |              |                 |              |
| Chrysophyceae (yellow - brown algae) |                     |                 |              |     |                              |              |                 |              |                 |              |                 |              |
| Dinobryon spp.                       |                     |                 |              |     |                              |              |                 |              |                 | 4            | .02             |              |
| Mallomonas spp.                      |                     |                 |              | 2   | .28                          |              |                 | 5            | .02             | 80           | .46             |              |
| CRYPTOPHYTA (cryptomonads)           |                     |                 | 51.30        |     | 80.47                        |              | 8.39            |              |                 |              |                 |              |
| Cryptophyceae                        |                     |                 |              |     |                              |              |                 |              |                 |              |                 |              |
| Chroomonas spp.                      | 87                  | 28.25           |              | 52  | 7.25                         |              |                 |              |                 |              |                 |              |
| Cryptomonas spp.                     | 71                  | 23.05           |              | 525 | 73.22                        | 24           | 8.39            |              |                 |              |                 |              |
| CYANOPHYTA (blue-green algae)        |                     |                 | 38.31        |     |                              |              |                 |              | 83.30           |              | 79.59           |              |
| Cyanophyceae                         |                     |                 |              |     |                              |              |                 |              |                 |              |                 |              |
| Anabaena spp.                        | 90                  | 29.22           |              |     |                              |              |                 | 3,480        | 12.74           | 900          | 5.19            |              |
| Aphanothece gelatinosa               |                     |                 |              |     |                              |              |                 | 6,550        | 23.98           | 2,450        | 14.14           |              |
| Coelosphaerium Kuetzingianum         |                     |                 |              |     |                              |              |                 | 12,420       | 45.48           | 10,440       | 60.26           |              |
| C. Naegelianum                       |                     |                 |              |     |                              |              |                 | 300          | 1.10            |              |                 |              |
| Dactylococcopsis Smithii             | 28                  | 9.09            |              |     |                              |              |                 |              |                 |              |                 |              |
| EUGLENOPHYTA (euglenoids)            |                     |                 | 1.95         |     |                              |              |                 |              |                 |              |                 |              |
| Euglenophyceae                       |                     |                 |              |     |                              |              |                 |              |                 |              |                 |              |
| Euglena spp.                         | 6                   | 1.95            |              |     |                              |              |                 |              |                 |              |                 |              |
| PYRRHOPHYTA (fire algae)             |                     |                 |              |     |                              |              |                 |              |                 |              | .04             |              |
| Dinophyceae (dinoflagellates)        |                     |                 |              |     |                              |              |                 |              |                 |              |                 |              |
| Ceratium hirundinella                |                     |                 |              |     |                              |              |                 |              |                 | 4            | .02             |              |
| Peridinium spp.                      |                     |                 |              |     |                              |              |                 |              |                 | 4            | .02             |              |
| Total number of cells                |                     | 308             |              | 717 |                              | 286          |                 | 27,309       |                 | 17,325       |                 |              |
| Total number of taxa                 |                     | 8               |              | 8   |                              | 6            |                 | 27           |                 | 27           |                 |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

|                                 | RESERVOIR 12--NEAR HINSDALE<br>LIVESTOCK COMPANY |       |         |       |         |       | RESERVOIR 13--SHARP RESERVOIR |       |         |       |         |        |
|---------------------------------|--|-------|---------|-------|---------|-------|-------------------------------|-------|---------|-------|---------|--------|
|                                 | 8-23-78  |       | 8-23-78 |       | 5-23-78 |       | 5-23-79                       |       | 8-15-79 |       | 8-15-79 |        |
|                                 | 1232   |       | 1235    |       | 1332    |       | 1336                          |       | 1700    |       | 1705    |        |
|                                 | 1.0 m  |       | 2.5 m   |       | 1.0 m   |       | 3.0 m                         |       | 0.00 m  |       | 2.5 m   |        |
| DATE:                           |  |       |         |       |         |       |                               |       |         |       |         |        |
| TIME:                           |  |       |         |       |         |       |                               |       |         |       |         |        |
| DEPTH:                          |  |       |         |       |         |       |                               |       |         |       |         |        |
|                                 | Cells  | Per-  | Cells   | Per-  | Cells   | Per-  | Cells                         | Per-  | Cells   | Per-  | Cells   | Per-   |
|                                 | per mL   | cent  | per mL  | cent  | per mL  | cent  | per mL                        | cent  | per mL  | cent  | per mL  | cent   |
| CHLOROPHYTA (green algae)       |  | 16.85 |         | 8.14  |         | 79.22 |                               | 64.46 |         |       |         | <0.05  |
| Chlorophyceae                   |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>Closterium</i> spp.          |  |       |         |       |         |       |                               |       |         |       |         | <1     |
| <i>Coelastrum microporum</i>    | 64   | 7.76  |         |       |         |       |                               |       |         |       |         | <.0    |
| <i>Cosmarium formosulum</i>     |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>C. spp.</i>                  |  |       |         |       |         |       |                               |       |         |       |         | <1     |
| <i>Crucigenia rectangularis</i> | 32   | 3.88  |         |       |         |       |                               |       |         |       |         | <.01   |
| <i>Oocystis</i> spp.            | 24   | 2.91  | 40      | 6.03  |         |       |                               |       |         |       |         |        |
| <i>Scenedesmus serratus</i>     | 8  | .97   |         |       |         |       |                               |       |         |       |         | <1     |
| <i>Schroederia setigera</i>     | 8  | .97   | 8       | 1.21  | 629     | 79.22 | 859                           | 61.05 |         |       |         | <.01   |
| <i>Sphaerocystis Schroeteri</i> |  |       |         |       |         |       | 48                            | 3.41  |         |       |         |        |
| <i>Tetraedron trigonum</i>      | 3  | .36   | 6       | .90   |         |       |                               |       |         |       |         |        |
| CHRYSOPHYTA                     |  | 3.88  |         | 3.77  |         | <.51  |                               | .78   |         | 0.01  |         | .02    |
| Bacillariophyceae (diatoms)     |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>Cocconeis placentula</i>     | 6  | .73   | 2       | .30   |         |       |                               |       | 9       | .01   | 8       | .02    |
| <i>Epithemia</i> spp.           |  |       | 1       | .15   |         |       |                               |       |         |       |         |        |
| <i>Gyrodinium</i> spp.          | 2  | .24   | 1       | .15   |         |       |                               |       |         |       |         |        |
| <i>Navicula</i> spp.            | 6  | .73   | 2       | .30   |         |       |                               |       |         |       |         |        |
| <i>Nitzschia acicularis</i>     |  |       |         |       | <1      | <.13  |                               |       |         |       |         |        |
| <i>N. spp.</i>                  |  |       | 9       | 1.36  |         |       |                               |       |         |       |         |        |
| <i>Synedra</i> spp.             | 18   | 2.18  | 10      | 1.51  | 3       | .38   | 11                            | .78   |         |       |         |        |
| CHRYPTOPHYTA (cryptomonads)     |  | 64.73 |         | 66.37 |         | 4.16  |                               | 15.14 |         | 1.31  |         | .19    |
| Cryptophyceae                   |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>Chroomonas</i> spp.          | 252  | 30.55 | 204     | 30.77 |         |       |                               |       | 871     | 1.31  | 60      | .15    |
| <i>Cryptomonas</i> spp.         | 282  | 34.18 | 236     | 35.60 | 33      | 4.16  | 213                           | 15.14 |         |       | 14      | .04    |
| CYANOPHYTA (blue-green algae)   |  | <7.39 |         | 12.36 |         | 15.12 |                               | 19.19 |         | 98.68 |         | <99.79 |
| Cyanophyceae                    |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>Anabaena spiroides</i>       |  |       |         |       | 90      | 11.34 | 180                           | 12.79 |         |       |         |        |
| <i>A. spp.</i>                  |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>Aphanizomenon flos-aquae</i> | 60   | 7.27  | 30      | 4.52  |         |       |                               |       | 65,500  | 98.34 | 39,000  | 99.74  |
| <i>Dactylococcopsis Smithii</i> |  |       | 2       | .30   |         |       |                               |       |         |       |         |        |
| <i>Microcystis incerta</i>      |  |       |         |       |         |       |                               |       |         |       |         | <1     |
| <i>Nostoc</i> spp.              | <1   | <.12  | 50      | 7.54  |         |       |                               |       |         |       |         | <.01   |
| <i>Oscillatoria</i> spp.        |  |       |         |       | 30      | 3.78  | 90                            | 6.40  |         |       |         | <.01   |
| <i>Synechocystis aquatilis</i>  |  |       |         |       |         |       |                               |       | 228     | .34   | 11      | .03    |
| EUGLENOPHYTA (euglenoids)       |  |       |         | .15   |         | 1.01  |                               | .43   |         | <.01  |         | .01    |
| Euglenophyceae                  |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>Euglena</i> spp.             |  |       | 1       | .15   |         |       |                               |       |         |       |         |        |
| <i>Trachelomonas</i> spp.       |  |       |         |       | 8       | 1.01  | 6                             | .43   | <1      | <.01  | 3       | .01    |
| PYRRHOPHYTA (fire algae)        |  | 7.15  |         | 9.20  |         |       |                               |       |         |       |         |        |
| Dinophyceae (dinoflagellates)   |  |       |         |       |         |       |                               |       |         |       |         |        |
| <i>Ceratium hirundinella</i>    | 59   | 7.15  | 61      | 9.20  |         |       |                               |       |         |       |         |        |
| Total number of cells           | 825  |       | 663     |       | 794     |       | 1,407                         |       | 66,609  |       | 39,101  |        |
| Total number of taxa            | 15   |       | 16      |       | 7       |       | 7                             |       | 5       |       | 11      |        |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 15--ALTERNATE RESERVOIR    |        |                 |              |                 |              |                 |              |                 |              |
|--------------------------------------|--------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
|                                      | DATE:  | 5-23-79         |              | 5-23-79         |              | 8-15-79         |              | 8-15-79         |              |
|                                      | TIME:  | 1001            |              | 1004            |              | 0900            |              | 0903            |              |
|                                      | DEPTH: | 0.50 m          |              | 2.0 m           |              | 0.00 m          |              | 1.5 m           |              |
|                                      |        | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)            |        | <6.23           |              | <9.59           |              | <0.23           |              | <0.06           |              |
| Chlorophyceae                        |        |                 |              |                 |              |                 |              |                 |              |
| <i>Ankistrodesmus falcatus</i>       |        |                 |              |                 |              |                 |              | <1              | <.02         |
| <i>Closterium</i> spp.               |        |                 |              | <1              | <.08         |                 |              |                 |              |
| <i>Oocystis</i> spp.                 |        |                 |              | 16              | 1.32         |                 |              |                 |              |
| <i>Scenedesmus bijuga</i>            |        |                 |              | <1              | <.08         |                 |              |                 |              |
| <i>S. serratus</i>                   |        |                 |              |                 |              | <1              | <.04         |                 |              |
| <i>Schroederia setigera</i>          | 21     | 1.87            |              | 17              | 1.41         | 5               | .19          | 2               | .04          |
| <i>Selenastrum minutum</i>           | <1     | <.09            |              | <1              | <.08         |                 |              |                 |              |
| <i>Sphaerocystis Schroeteri</i>      | 48     | 4.27            |              | 80              | 6.62         |                 |              |                 |              |
| CHRYSTOPHYTA                         |        | .80             |              | <4.14           |              | <1.56           |              | <.54            |              |
| Bacillariophyceae (diatoms)          |        |                 |              |                 |              |                 |              |                 |              |
| <i>Cocconeis placentula</i>          | <1     | <.09            |              |                 |              | 31              | 1.21         | 26              | .52          |
| <i>Cymbella minuta</i>               |        |                 |              | <1              | <.08         |                 |              |                 |              |
| <i>Diploneis</i> spp.                |        |                 |              |                 |              | <1              | <.04         |                 |              |
| <i>Navicula salinarum</i>            |        |                 |              |                 |              | 2               | .08          | <1              | <.02         |
| <i>N. spp.</i>                       | <1     | <.09            |              | 3               | .25          |                 |              |                 |              |
| <i>Nitzschia Kuetzingiana</i>        |        |                 |              |                 |              | 6               | .23          |                 |              |
| <i>N. palea</i>                      | 5      | .44             |              |                 |              |                 |              |                 |              |
| <i>Synedra ulna</i>                  | <1     | <.09            |              | 2               | .17          |                 |              |                 |              |
| Chrysophyceae (yellow - brown algae) |        |                 |              |                 |              |                 |              |                 |              |
| <i>Dinobryon</i> spp.                | <1     | <.09            |              | <1              | <.08         |                 |              |                 |              |
| <i>Ochromonas</i> spp.               |        |                 |              | 43              | 3.56         |                 |              |                 |              |
| CRYPTOPHYTA (cryptomonads)           |        | 79.54           |              | 78.74           |              | 11.60           |              | 3.64            |              |
| Cryptophyceae                        |        |                 |              |                 |              |                 |              |                 |              |
| <i>Chroomonas</i> spp.               | 856    | 76.16           |              | 719             | 59.47        | 243             | 9.46         | 145             | 2.90         |
| <i>Cryptomonas</i> spp.              | 38     | 3.38            |              | 233             | 19.27        | 55              | 2.14         | 37              | .74          |
| CYANOPHYTA (blue-green algae)        |        | <13.44          |              | <7.52           |              | <86.30          |              | <95.73          |              |
| Cyanophyceae                         |        |                 |              |                 |              |                 |              |                 |              |
| <i>Anabaena</i> spp.                 | 150    | 13.35           |              | 90              | 7.44         | <1              | <.04         | 240             | 4.80         |
| <i>Aphanizomenon flos-aquae</i>      |        |                 |              |                 |              | 1,400           | 54.47        | 1,160           | 23.18        |
| <i>Coelosphaerium</i> spp.           | <1     | <.09            |              | <1              | <.08         |                 |              |                 |              |
| <i>Dactylococcopsis</i> spp.         |        |                 |              |                 |              | 2               | .08          |                 |              |
| <i>Merismopedia tenuissima</i>       |        |                 |              |                 |              |                 |              | <1              | <.02         |
| <i>Microcystis incerta</i>           |        |                 |              |                 |              | 300             | 11.67        | 1,400           | 27.98        |
| <i>Oscillatoria</i> spp.             |        |                 |              |                 |              | 480             | 18.68        | 150             | 3.00         |
| <i>Synechococcus</i> spp.            |        |                 |              |                 |              | 11              | .43          | 3               | .06          |
| <i>Synechocystis aquatilis</i>       |        |                 |              |                 |              | 24              | .93          | 1,836           | 36.69        |
| EUGLENOPHYTA (euglenoids)            |        |                 |              |                 |              | .31             |              | .04             |              |
| Euglenophyceae                       |        |                 |              |                 |              |                 |              |                 |              |
| <i>Trachelomonas</i> spp.            |        |                 |              |                 |              | 8               | .31          | 2               | .04          |
| Total number of cells                |        | 1,124           |              | 1,209           |              | 2,570           |              | 5,004           |              |
| Total number of taxa                 |        | 12              |              | 15              |              | 16              |              | 14              |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 18--COOL PIT RESERVOIR     |               |       |         |        |         |        |         |       |
|--------------------------------------|---------------|-------|---------|--------|---------|--------|---------|-------|
|                                      | DATE: 5-24-79 |       | 5-24-79 |        | 8-15-79 |        | 8-15-79 |       |
|                                      | TIME: 1301    |       | 1306    |        | 1200    |        | 1206    |       |
|                                      | DEPTH: 0.50 m |       | 3.0 m   |        | 0.00 m  |        | 3.0 m   |       |
|                                      | Cells         | Per-  | Cells   | Per-   | Cells   | Per-   | Cells   | Per-  |
|                                      | per mL        | cent  | per mL  | cent   | per mL  | cent   | per mL  | cent  |
| CHLOROPHYTA (green algae)            |               | <3.06 |         | <21.17 |         | 2.77   |         | 2.69  |
| Chlorophyceae                        |               |       |         |        |         |        |         |       |
| <i>Ankistrodesmus falcatus</i>       | <1            | <.17  | 4       | 1.11   |         |        | 3       | .27   |
| <i>Cosmarium formosulum</i>          |               |       |         |        | 1       | .04    |         |       |
| <i>C. spp.</i>                       |               |       |         |        |         |        | 2       | .18   |
| <i>Euastrum spp.</i>                 |               |       | <1      | <.28   |         |        |         |       |
| <i>Oocystis spp.</i>                 |               |       | 32      | 8.91   |         |        |         |       |
| <i>Scenedesmus bijuga</i>            |               |       |         |        |         |        | 8       | .72   |
| <i>S. opoliensis</i>                 |               |       | 8       | 2.23   |         |        |         |       |
| <i>S. serratus</i>                   |               |       |         |        | 16      | .65    | 16      | 1.43  |
| <i>Schroederia setigera</i>          | 17            | 2.89  | 29      | 8.08   |         |        |         |       |
| <i>Selenastrum minutum</i>           |               |       | <1      | <.28   |         |        |         |       |
| <i>Sphaerocystis Schroeteri</i>      |               |       |         |        | 48      | 1.96   |         |       |
| <i>Tetraedron minimum</i>            |               |       | <1      | <.28   |         |        | 1       | .09   |
| <i>T. trigonum</i>                   |               |       |         |        | 3       | .12    |         |       |
| CHRYSTOPHYTA                         |               | <5.44 |         | <26.19 |         | <3.27  |         | 7.89  |
| Bacillariophyceae (diatoms)          |               |       |         |        |         |        |         |       |
| <i>Cocconeis placentula</i>          | <1            | <.17  | <1      | <.28   | 7       | .29    | 8       | .72   |
| <i>Fragilaria spp.</i>               |               |       | <1      | <.28   |         |        |         |       |
| <i>Navicula cryptocephala</i>        |               |       |         |        | <1      | <.04   | 3       | .27   |
| <i>N. peregrina</i>                  | 1             | .17   |         |        |         |        |         |       |
| <i>N. spp.</i>                       |               |       | <1      | <.28   |         |        |         |       |
| <i>Nitzschia acicularis</i>          | 10            | 1.70  | 5       | 1.39   | <1      | <.04   |         |       |
| <i>N. fonticola</i>                  |               |       |         |        | 34      | 1.39   | 12      | 1.08  |
| <i>N. palea</i>                      | 11            | 1.87  | 12      | 3.34   | 37      | 1.51   | 65      | 5.82  |
| <i>N. stagnorum</i>                  | 5             | .85   | 10      | 2.79   |         |        |         |       |
| <i>Stephanodiscus spp.</i>           | <1            | <.17  |         |        |         |        |         |       |
| <i>Surirella ovata</i>               | 1             | .17   |         |        |         |        |         |       |
| <i>Synedra ulna</i>                  |               |       | <1      | <.28   |         |        |         |       |
| Chrysophyceae (yellow - brown algae) |               |       |         |        |         |        |         |       |
| <i>Ochromonas spp.</i>               | 2             | .34   | 63      | 17.55  |         |        |         |       |
| CRYPTOPHYTA (cryptomonads)           |               | 45.57 |         | 21.17  |         | 18.08  |         | 15.59 |
| Cryptophyceae                        |               |       |         |        |         |        |         |       |
| <i>Chroomonas spp.</i>               | 218           | 37.07 | 20      | 5.57   | 221     | 9.04   | 97      | 8.69  |
| <i>Cryptomonas spp.</i>              | 50            | 8.50  | 56      | 15.60  | 221     | 9.04   | 77      | 6.90  |
| CYANOPHYTA (blue-green algae)        |               | 45.92 |         | <31.48 |         | <75.62 |         | 72.14 |
| Cyanophyceae                         |               |       |         |        |         |        |         |       |
| <i>Anabaena spp.</i>                 | 270           | 45.92 |         |        | <1      | <.04   | 150     | 13.44 |
| <i>Aphanizomenon flos-aquae</i>      |               |       |         |        | 600     | 24.53  | 80      | 7.17  |
| <i>Coelosphaerium spp.</i>           |               |       | 112     | 31.20  |         |        |         |       |
| <i>Dactylococcopsis Smithii</i>      |               |       | <1      | <.28   |         |        |         |       |
| <i>D. spp.</i>                       |               |       |         |        |         |        | 2       | .18   |
| <i>Merismopedia glauca</i>           |               |       |         |        | 48      | 1.96   | 32      | 2.87  |
| <i>Microcystis incerta</i>           |               |       |         |        | 300     | 12.26  | 300     | 26.88 |
| <i>Oscillatoria spp.</i>             |               |       |         |        | 900     | 36.79  | 240     | 21.51 |
| <i>Spirulina spp.</i>                |               |       |         |        | <1      | <.04   | 1       | .09   |
| EUGLENOPHYTA (euglenoids)            |               |       |         |        |         | .25    |         | 1.70  |
| Euglenophyceae                       |               |       |         |        |         |        |         |       |
| <i>Euglena spp.</i>                  |               |       |         |        | 6       | .25    | 14      | 1.25  |
| <i>Phacus spp.</i>                   |               |       |         |        |         |        | 4       | .36   |
| <i>Trachelomonas spp.</i>            |               |       |         |        |         |        | 1       | .09   |
| Total number of cells                | 588           |       | 359     |        | 2,446   |        | 1,116   |       |
| Total number of taxa                 | 13            |       | 19      |        | 18      |        | 21      |       |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 19--KING RESERVOIR         |         |              |          |              |          |              |          |              |          |
|--------------------------------------|---------|--------------|----------|--------------|----------|--------------|----------|--------------|----------|
|                                      | 5-22-79 |              | 5-22-79  |              | 8-14-79  |              | 8-14-79  |              |          |
|                                      | DATE:   | TIME:        | DATE:    | TIME:        | DATE:    | TIME:        | DATE:    | TIME:        |          |
|                                      | DEPTH:  | 0.50 m       | DEPTH:   | 2.5 m        | DEPTH:   | 0.50 m       | DEPTH:   | 3.5 m        |          |
|                                      |         | Cells per mL | Per cent | Cells per mL | Per cent | Cells per mL | Per cent | Cells per mL | Per cent |
| CHLOROPHYTA (green algae)            |         | <65.43       |          | <48.75       |          | <20.98       |          | <28.55       |          |
| Chlorophyceae                        |         |              |          |              |          |              |          |              |          |
| <i>Ankistrodesmus falcatus</i>       |         | 12           | .84      | 8            | .83      | 704          | .39      | 1,326        | .79      |
| <i>Characium</i> spp.                |         |              |          |              |          | 29           | .02      |              |          |
| <i>Coelastrum cambricum</i>          |         |              |          |              |          |              |          | <1           | <.01     |
| <i>C. microporum</i>                 |         | 192          | 13.45    | 64           | 6.67     | 1,888        | 1.04     | 3,648        | 2.17     |
| <i>Cosmarium</i> spp.                |         |              |          | <1           | <.10     | <1           | <.01     | <1           | <.01     |
| <i>Dictyosphaerium pulchellum</i>    |         | 96           | 6.73     |              |          | <1           | <.01     | 608          | .36      |
| <i>Gloeocystis planctonica</i>       |         |              |          |              |          | 4,704        | 2.59     | 8,480        | 5.05     |
| <i>Golenkinia radiata</i>            |         |              |          |              |          | 29           | .02      | 76           | .05      |
| <i>Kirchneriella</i> spp.            |         |              |          |              |          | 19,472       | 10.73    | 22,120       | 13.17    |
| <i>Oocystis</i> spp.                 |         | 168          | 11.77    | 96           | 10.00    | 2,576        | 1.42     | 4,848        | 2.89     |
| <i>Pediastrum Boryanum</i>           |         | <1           | <.07     |              |          | 464          | .26      | <1           | <.01     |
| <i>P. tetras</i>                     |         |              |          |              |          | <1           | <.01     |              |          |
| <i>Scenedesmus abundans</i>          |         |              |          |              |          | 588          | .32      | 304          | .18      |
| <i>S. bijuga</i>                     |         | 180          | 12.61    | 12           | 1.25     | 2,228        | 1.23     | 2,120        | 1.26     |
| <i>S. dimorphus</i>                  |         | 12           | .84      | 8            | .83      | 116          | .06      | <1           | <.01     |
| <i>S. opoliensis</i>                 |         | 168          | 11.77    | 224          | 23.33    | 1,760        | .97      | 2,120        | 1.26     |
| <i>S. serratus</i>                   |         |              |          |              |          | 704          | .39      | 456          | .27      |
| <i>Schroederia setigera</i>          |         |              |          |              |          | 59           | .03      |              |          |
| <i>Selenastrum minutum</i>           |         | 18           | 1.26     | 3            | .31      | 616          | .34      | 530          | .32      |
| <i>Staurostrum</i> spp.              |         |              |          |              |          | <1           | <.01     | 76           | .05      |
| <i>Tetraedron minimum</i>            |         | 42           | 2.94     | 30           | 3.13     | 1,202        | .66      | 795          | .47      |
| <i>T. trigonum</i>                   |         | 9            | .63      | 6            | .63      | 117          | .06      | 38           | .02      |
| <i>Tetrastrum staurogeniaeforme</i>  |         | 36           | 2.52     | 16           | 1.67     | 704          | .39      | 304          | .18      |
| <i>Treubaria setigerum</i>           |         |              |          |              |          | 29           | .02      | 38           | .02      |
| CHRYSTOPHYTA                         |         | <1.89        |          | <1.74        |          | <.16         |          |              | .25      |
| Bacillariophyceae (diatoms)          |         |              |          |              |          |              |          |              |          |
| <i>Cocconeis placentula</i>          |         |              |          | <1           | <.01     |              |          |              |          |
| <i>Cymbella</i> spp.                 |         |              |          | <1           | <.01     |              |          |              |          |
| <i>Diploneis</i> spp.                |         |              |          | <1           | <.01     |              |          |              |          |
| <i>Epithemia</i> spp.                |         |              |          |              |          | 29           | .02      |              |          |
| <i>Fragilaria</i> spp.               |         |              |          |              |          |              |          | 152          | .09      |
| <i>Gyrosigma macrum</i>              |         |              |          |              |          | <1           | <.01     |              |          |
| <i>Navicula salinarum</i>            |         | 6            | .42      | 2            | .21      |              |          |              |          |
| <i>Nitzschia acicularis</i>          |         | <1           | <.07     | 8            | .83      |              |          |              |          |
| <i>N. filiformes</i>                 |         |              |          | <1           | <.10     |              |          |              |          |
| <i>N. gracilis</i>                   |         | <1           | <.07     |              |          |              |          |              |          |
| <i>N. palea</i>                      |         |              |          | <1           | <.10     | 29           | .02      | 76           | .05      |
| <i>N. stagnorum</i>                  |         |              |          | <1           | <.10     |              |          |              |          |
| <i>Synedra ulna</i>                  |         | <1           | <.07     | <1           | <.10     | 205          | .11      | 152          | .09      |
| <i>S. spp.</i>                       |         | 18           | 1.26     |              |          |              |          |              |          |
| Chrysophyceae (yellow - brown algae) |         |              |          |              |          |              |          |              |          |
| <i>Dinobryon</i> spp.                |         |              |          |              |          |              |          | 38           | .02      |
| CRYPTOPHYTA (cryptomonads)           |         | 31.04        |          | 36.35        |          | 2.62         |          |              | 2.68     |
| Cryptophyceae                        |         |              |          |              |          |              |          |              |          |
| <i>Chroomonas</i> spp.               |         | 279          | 19.55    | 229          | 23.85    | 1,290        | .71      | 758          | .45      |
| <i>Cryptomonas</i> spp.              |         | 164          | 11.49    | 120          | 12.50    | 3,460        | 1.91     | 3,750        | 2.23     |
| CYANOPHYTA (blue-green algae)        |         | <.14         |          | 9.58         |          | 76.10        |          |              | 68.41    |
| Cyanophyceae                         |         |              |          |              |          |              |          |              |          |
| <i>Anabaena helicoidea</i>           |         |              |          |              |          | 870          | .48      | <1           | <.01     |
| <i>A. spiroides</i>                  |         |              |          |              |          | 5,280        | 2.91     | 6,810        | 4.05     |
| <i>A. spp.</i>                       |         | <1           | <.07     | 60           | 6.25     |              |          |              |          |
| <i>Anabaenopsis</i> spp.             |         |              |          |              |          | 3,510        | 1.93     | 3,420        | 2.04     |
| <i>Aphanizomenon flos-aquae</i>      |         |              |          |              |          | 33,440       | 18.43    | 34,840       | 20.74    |
| <i>Aphanothece saxicola</i>          |         |              |          |              |          | 58,650       | 32.32    | 30,300       | 18.04    |
| <i>Coelosphaerium Kuetzingianum</i>  |         |              |          |              |          | 7,020        | 3.87     | 2,280        | 1.36     |
| <i>C. spp.</i>                       |         | <1           | <.07     |              |          |              |          |              |          |
| <i>Gomphosphaeria lacustris</i>      |         |              |          |              |          | 3,744        | 2.06     | 1,216        | .72      |
| <i>Merismopedia tenuissima</i>       |         |              |          | 32           | 3.33     | 7,968        | 4.39     | 14,544       | 8.66     |
| <i>Microcystis incerta</i>           |         |              |          |              |          | 11,700       | 6.45     | 15,200       | 9.05     |
| <i>Oscillatoria</i> spp.             |         |              |          |              |          | 5,280        | 2.91     | 5,670        | 3.38     |
| <i>Synechococcus</i> spp.            |         |              |          |              |          | 645          | .36      | 606          | .36      |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 19--KING RESERVOIR--Continued |                 |              |                 |              |                 |              |                 |              |
|---|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
| DATE:                                   | 5-22-79         |              | 5-22-79         |              | 8-14-79         |              | 8-14-79         |              |
| TIME:                                   | 0931            |              | 0935            |              | 0901            |              | 0907            |              |
| DEPTH:                                  | 0.50 m          |              | 2.5 m           |              | 0.50 m          |              | 3.5 m           |              |
|   | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| EUGLENOPHYTA (euglenoids)               |                 | 1.26         |                 | 3.33         |                 | <.09         |                 | .04          |
| Euglenophyceae                          |                 |              |                 |              |                 |              |                 |              |
| <i>Euglena</i> spp.                     |                 |              |                 |              | <1              | <.01         |                 |              |
| <i>Phacus</i> spp.                      |                 |              |                 |              |                 |              | 38              | .02          |
| <i>Trachelomonas</i> spp.               | 18              | 1.26         | 32              | 3.33         | 147             | .08          | 38              | .02          |
| PYRRHOPHYTA (fire algae)                |                 | .21          |                 | .21          |                 | .11          |                 | .11          |
| Dinophyceae (dinoflagellates)           |                 |              |                 |              |                 |              |                 |              |
| <i>Peridinium</i> spp.                  | 3               | .21          | 2               | .21          | 205             | .11          | 189             | .11          |
| Total number of cells                   | 1,427           |              | 960             |              | 181,467         |              | 167,969         |              |
| Total number of taxa                    | 23              |              | 26              |              | 43              |              | 41              |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| Reservoir 20--PR-18               |         |       |         |        |         |       |         |       |       |
|-----------------------------------|---------|-------|---------|--------|---------|-------|---------|-------|-------|
|                                   | 5-22-79 |       | 5-22-79 |        | 8-14-79 |       | 8-14-79 |       |       |
|                                   | DATE:   | TIME: | DATE:   | TIME:  | DATE:   | TIME: | DATE:   | TIME: |       |
|                                   | DEPTH:  | 1.0 m | 4.5 m   | 0.50 m | 4.5 m   |       |         |       |       |
|                                   | Cells   | Per-  | Cells   | Per-   | Cells   | Per-  | Cells   | Per-  |       |
|                                   | per mL  | cent  | per mL  | cent   | per mL  | cent  | per mL  | cent  |       |
| CHLOROPHYTA (green algae)         |         | 87.80 |         | 92.81  |         | 0.11  |         |       |       |
| Chlorophyceae                     |         |       |         |        |         |       |         |       |       |
| <i>Dictyosphaerium pulchellum</i> | 8       | 1.63  |         |        |         |       |         |       |       |
| <i>Scenedesmus</i> spp.           |         |       |         |        | 76      | .11   |         |       |       |
| <i>Schroederia setigera</i>       | 102     | 20.73 | 73      | 22.81  |         |       |         |       |       |
| <i>Sphaerocystis Schroeteri</i>   | 320     | 65.04 | 224     | 70.00  |         |       |         |       |       |
| CHRYSTOPHYTA                      |         | <.40  |         | .31    |         | .01   |         |       | <0.05 |
| Bacillariophyceae (diatoms)       |         |       |         |        |         |       |         |       |       |
| <i>Cocconeis placentula</i>       |         |       |         |        | 9       | .01   | 5       | .04   |       |
| <i>Navicula</i> spp.              | 1       | .20   |         |        |         |       |         |       |       |
| <i>Rhoicosphenia curvata</i>      |         |       |         |        |         |       | <1      | <.01  |       |
| <i>Synedra ulna</i>               | <1      | <.20  | 1       | .31    |         |       |         |       |       |
| CRYPTOPHYTA (cryptomonads)        |         | 11.38 |         | 5.94   |         | .05   |         |       | <.12  |
| Cryptophyceae                     |         |       |         |        |         |       |         |       |       |
| <i>Chroomonas</i> spp.            | 13      | 2.64  |         |        | 28      | .04   | <1      | <.01  |       |
| <i>Cryptomonas</i> spp.           | 43      | 8.74  | 19      | 5.94   | 9       | .01   | 15      | .11   |       |
| CYANOPHYTA (blue-green algae)     |         |       |         | <.31   |         | 99.82 |         |       | 99.82 |
| Cyanophyceae                      |         |       |         |        |         |       |         |       |       |
| <i>Aphanizomenon flos-aquae</i>   |         |       |         |        | 41,280  | 61.06 | 7,080   | 53.36 |       |
| <i>Dactylococcopsis</i> spp.      |         |       |         |        |         |       | 15      | .11   |       |
| <i>Microcystis incerta</i>        |         |       |         |        | 1,900   | 2.81  | 1,500   | 11.30 |       |
| <i>Oscillatoria</i> spp.          |         |       | <1      | <.31   | 10,800  | 15.98 | 2,580   | 19.44 |       |
| <i>Synechococcus</i> spp.         |         |       |         |        | 385     | .57   | 808     | 6.09  |       |
| <i>Synechocystis aquatilis</i>    |         |       |         |        | 13,116  | 19.40 | 1,263   | 9.52  |       |
| EUGLENOPHYTA (euglenoids)         |         | .81   |         | .63    |         |       |         |       | <.01  |
| Euglenophyceae                    |         |       |         |        |         |       |         |       |       |
| <i>Euglena</i> spp.               |         |       |         |        |         |       | <1      | <.01  |       |
| <i>Trachelomonas</i> spp.         | 4       | .81   | 2       | .63    |         |       |         |       |       |
| Total number of cells             | 492     |       | 320     |        | 67,603  |       | 13,269  |       |       |
| Total number of taxa              | 8       |       | 6       |        | 9       |       | 11      |       |       |



Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

| RESERVOIR 22--PR-71             |                 |              |                 |              |                 |              |                 |              |
|---------------------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
| DATE:                           | 5-21-79         |              | 5-21-79         |              | 8-13-79         |              | 8-13-79         |              |
| TIME:                           | 1101            |              | 1104            |              | 0901            |              | 0903            |              |
| DEPTH:                          | 0.50 m          |              | 2.0 m           |              | 0.50 m          |              | 2.0 m           |              |
|                                 | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent |
| CHLOROPHYTA (green algae)       |                 | <30.00       |                 | <47.82       |                 | <14.54       |                 | <13.41       |
| Chlorophyceae                   |                 |              |                 |              |                 |              |                 |              |
| <i>Ankistrodesmus falcatus</i>  |                 |              |                 |              | <1              | <.06         | 2               | .19          |
| <i>Crucigenia crucifera</i>     |                 |              | 6               | 3.26         |                 |              |                 |              |
| <i>C. tetrapedia</i>            |                 |              | 6               | 3.26         |                 |              |                 |              |
| <i>Elakatothrix gelatinosa</i>  |                 |              | 2               | 1.09         |                 |              |                 |              |
| <i>Oocystis</i> spp.            | <1              | <2.50        | 8               | 4.35         |                 |              |                 |              |
| <i>Pediastrum Boryanum</i>      |                 |              | 6               | 3.26         | 48              | 2.69         | <1              | <.09         |
| <i>P. tetras</i>                |                 |              |                 |              |                 |              | <1              | <.09         |
| <i>Scenedesmus abundans</i>     |                 |              |                 |              | <1              | <.06         | 20              | 1.88         |
| <i>S. bijuga</i>                |                 |              |                 |              | 32              | 1.79         | 24              | 2.25         |
| <i>S. dimorphus</i>             |                 |              |                 |              |                 |              | 4               | .38          |
| <i>S. opoliensis</i>            | <1              | <2.50        | 12              | 6.52         | 88              | 4.94         | 24              | 2.25         |
| <i>S. serratus</i>              |                 |              |                 |              | 76              | 4.26         | 44              | 4.13         |
| <i>Schroederia setigera</i>     | 1               | 2.50         | 14              | 7.61         | 11              | .62          | 6               | .56          |
| <i>Sphaerocystis Schroeteri</i> | 9               | 22.50        | 32              | 17.39        | <1              | <.06         | 16              | 1.50         |
| <i>Tetraedron minimum</i>       |                 |              | <1              | <.54         | <1              | <.06         | <1              | <.09         |
| <i>T. trigonum</i>              |                 |              | <1              | <.54         |                 |              |                 |              |
| <i>Westella</i> spp.            |                 |              |                 |              |                 |              |                 |              |
| CHRYSTOPHYTA                    |                 | <5.00        |                 | <3.26        |                 | <2.26        |                 | <2.25        |
| Bacillariophyceae (diatoms)     |                 |              |                 |              |                 |              |                 |              |
| <i>Cocconeis placentula</i>     |                 |              |                 |              | 28              | 1.57         | 15              | 1.41         |
| <i>Diploneis</i> spp.           |                 |              |                 |              | <1              | <.06         | 1               | .09          |
| <i>Gyrosigma</i> spp.           |                 |              |                 |              |                 |              | <1              | <.09         |
| <i>Navicula pupula</i>          |                 |              |                 |              | 3               | .17          |                 |              |
| <i>N. salinarum</i>             | <1              | <2.50        |                 |              | 3               | .17          |                 |              |
| <i>Nitzschia acicularis</i>     |                 |              | <1              | <.54         |                 |              |                 |              |
| <i>N. palea</i>                 |                 |              |                 |              | 3               | .17          | 4               | .38          |
| <i>N. subtilis</i>              |                 |              |                 |              |                 |              | 2               | .19          |
| <i>Pinnularia nodosa</i>        |                 |              |                 |              | <1              | <.06         |                 |              |
| <i>Synedra rumpens</i>          | <1              | <2.50        | 5               | 2.72         | <1              | <.06         | 1               | .09          |
| CRYPTOPHYTA (cryptomonads)      |                 | 60.00        |                 | 38.58        |                 | 51.09        |                 | 52.68        |
| Cryptophyceae                   |                 |              |                 |              |                 |              |                 |              |
| <i>Chroomonas</i> spp.          |                 |              | 7               | 3.80         | 74              | 4.15         | 113             | 10.61        |
| <i>Cryptomonas</i> spp.         | 24              | 60.00        | 64              | 34.78        | 837             | 46.94        | 448             | 42.07        |
| CYANOPHYTA (blue-green algae)   |                 |              |                 | 6.52         |                 | 31.63        |                 | 30.52        |
| Cyanophyceae                    |                 |              |                 |              |                 |              |                 |              |
| <i>Anabaena</i> spp.            |                 |              | 12              | 6.52         |                 |              |                 |              |
| <i>Merismopedia tenuissima</i>  |                 |              |                 |              | 48              | 2.69         | 16              | 1.50         |
| <i>Oscillatoria</i> spp.        |                 |              |                 |              | 510             | 28.60        | 300             | 28.17        |
| <i>Synechococcus</i> spp.       |                 |              |                 |              | 6               | .34          | 9               | .85          |
| EUGLENOPHYTA (euglenoids)       |                 | 5.00         |                 | 3.80         |                 | <.51         |                 | 1.03         |
| Euglenophyceae                  |                 |              |                 |              |                 |              |                 |              |
| <i>Euglena</i> spp.             |                 |              |                 |              | <1              | <.06         |                 |              |
| <i>Trachelomonas</i> spp.       | 2               | 5.00         | 7               | 3.80         | 8               | .45          | 11              | 1.03         |
| PYRRHOPHYTA (fire algae)        |                 |              |                 |              |                 |              |                 | <.09         |
| Dinophyceae (dinoflagellates)   |                 |              |                 |              |                 |              |                 |              |
| <i>Peridinium</i> spp.          |                 |              |                 |              |                 |              | <1              | <.09         |
| Total number of cells           | 40              |              | 184             |              | 1,783           |              | 1,065           |              |
| Total number of taxa            | 8               |              | 16              |              | 23              |              | 24              |              |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

|                                      | RESERVOIR 23--BENNET LAKE |                 |              |                 | RESERVOIR 24--EMPIRE RESERVOIR |                 |              |      |
|--------------------------------------|---------------------------|-----------------|--------------|-----------------|--------------------------------|-----------------|--------------|------|
|                                      | DATE:                     | 5-22-79         | 8-14-79      |                 | 5-21-79                        | 8-13-79         |              |      |
|                                      | TIME:                     | 1532            | 1532         |                 | 1602                           | 1333            |              |      |
|                                      | DEPTH:                    | 1.0 m           | 1.0 m        |                 | 1.0 m                          | 1.5 m           |              |      |
|                                      |                           | Cells<br>per mL | Per-<br>cent | Cells<br>per mL | Per-<br>cent                   | Cells<br>per mL | Per-<br>cent |      |
| CHLOROPHYTA (green algae)            |                           | <42.86          |              | <1.66           |                                | <35.27          |              | 7.36 |
| Chlorophyceae                        |                           |                 |              |                 |                                |                 |              |      |
| <i>Actinastrum Hantzschii</i>        |                           | 1               | .12          |                 | 96                             | .54             | 3,456        | .23  |
| <i>Ankistrodesmus falcatus</i>       |                           |                 |              |                 | 125                            | .70             | 541          | .04  |
| <i>Characium</i> spp.                |                           |                 |              | 10              |                                |                 |              |      |
| <i>Chodatella quadriseta</i>         |                           |                 |              |                 | 6                              | .03             | 216          | .01  |
| <i>Coelastrum microporum</i>         |                           |                 |              |                 | 192                            | 1.08            | 13,824       | .91  |
| <i>Cosmarium</i> spp.                |                           |                 |              |                 |                                |                 | 4,653        | .31  |
| <i>Crucigenia quadrata</i>           |                           | 272             | 32.93        |                 |                                |                 | <1           | <.01 |
| <i>Dictyosphaerium pulchellum</i>    |                           |                 |              |                 | 4,288                          | 24.07           | 29,440       | 1.95 |
| <i>Elakatothrix gelatinosa</i>       |                           |                 |              |                 | 12                             | .07             |              |      |
| <i>Eudorina elegans</i>              |                           |                 |              |                 | 272                            | 1.53            |              |      |
| <i>Gloeocystis planctonica</i>       |                           |                 |              |                 |                                |                 | 6,912        | .46  |
| <i>Golenkinia radiata</i>            |                           |                 |              |                 |                                |                 | 649          | .04  |
| <i>Kirchneriella</i> spp.            |                           |                 |              |                 |                                |                 | 23,376       | 1.55 |
| <i>Pediastrum duplex</i>             |                           |                 |              |                 |                                |                 | 1,728        | .11  |
| <i>P. tetras</i>                     |                           |                 |              |                 |                                |                 | 3,456        | .23  |
| <i>Scenedesmus abundans</i>          |                           |                 |              |                 | 68                             | .38             | 3,032        | .20  |
| <i>S. bijuga</i>                     |                           |                 |              |                 | 56                             | .31             | 8,656        | .57  |
| <i>S. dimorphus</i>                  |                           |                 |              |                 | 56                             | .31             | 5,196        | .34  |
| <i>S. opoliensis</i>                 |                           | <1              | <.12         | <1              | 36                             | .20             | 1,732        | .11  |
| <i>S. producto - capitatus</i>       |                           |                 |              |                 |                                |                 | <1           | <.01 |
| <i>S. serratus</i>                   |                           |                 |              |                 | 12                             | .07             | 1,300        | .09  |
| <i>Schroederia setigera</i>          |                           | 80              | 9.69         |                 |                                |                 | 325          | .02  |
| <i>Selenastrum minutum</i>           |                           |                 |              |                 |                                |                 | 974          | .06  |
| <i>Sphaerocystis Schroeteri</i>      |                           |                 |              |                 | <1                             | <.01            |              |      |
| <i>Spondylosium planum</i>           |                           |                 |              |                 | 6                              | .03             |              |      |
| <i>Staurastrum leptocladum</i>       |                           |                 |              |                 | 20                             | .11             |              |      |
| <i>S. spp.</i>                       |                           |                 |              |                 |                                |                 | 325          | .02  |
| <i>Tetraedron minimum</i>            |                           |                 |              |                 | 6                              | .03             | 325          | .02  |
| <i>T. pentaedricum</i>               |                           |                 |              |                 |                                |                 | <1           | <.01 |
| <i>T. trigonum</i>                   |                           |                 |              |                 |                                |                 | 325          | .02  |
| <i>Tetrastrum staurogeniaeforme</i>  |                           |                 |              |                 | 12                             | .07             | 432          | .03  |
| <i>Treubaria setigerum</i>           |                           |                 |              |                 | 9                              | .05             | 216          | .01  |
| <i>Ulothrix subtilissima</i>         |                           |                 |              |                 | 1,000                          | 5.61            |              |      |
| CHRYSTOPHYTA                         |                           | <2.29           |              | 12.64           |                                | 2.67            |              | <.26 |
| Bacillariophyceae (diatoms)          |                           |                 |              |                 |                                |                 |              |      |
| <i>Asterionella formosa</i>          |                           |                 |              |                 | 23                             | .13             |              |      |
| <i>Cocconeis placentula</i>          |                           | <1              | <.12         | 64              |                                |                 | <1           | <.01 |
| <i>Cyclotella pseudostelligera</i>   |                           |                 |              | 5               |                                |                 |              |      |
| <i>C. spp.</i>                       |                           | 6               | .73          |                 |                                |                 |              |      |
| <i>Cymbella minuta</i>               |                           |                 |              |                 | 3                              | .02             |              |      |
| <i>Fragilaria vaucheriae</i>         |                           | 4               | .48          |                 |                                |                 |              |      |
| <i>Melosira granulata</i>            |                           |                 |              |                 | 35                             | .20             |              |      |
| <i>Navicula cuspidata</i>            |                           | 2               | .24          |                 |                                |                 |              |      |
| <i>N. salinarum</i>                  |                           |                 |              |                 |                                |                 | <1           | <.01 |
| <i>N. viridula</i>                   |                           |                 |              |                 | 6                              | .03             |              |      |
| <i>Nitzschia acicularis</i>          |                           |                 |              |                 | 250                            | 1.40            | 1,299        | .09  |
| <i>N. amphibia</i>                   |                           | 2               | .24          | 2               |                                |                 |              |      |
| <i>N. Kuetzingiana</i>               |                           |                 |              | 5               |                                |                 |              |      |
| <i>N. Ovalis</i>                     |                           | <1              | <.12         |                 |                                |                 |              |      |
| <i>N. palea</i>                      |                           | 2               | .24          | 2               |                                |                 |              |      |
| <i>N. stagnorum</i>                  |                           |                 |              |                 |                                |                 | 433          | .03  |
| <i>Rhoicosphenia curvata</i>         |                           |                 |              | 6               |                                |                 |              |      |
| <i>Stephanodiscus</i> spp.           |                           |                 |              |                 | 73                             | .41             |              |      |
| <i>Synedra ulna</i>                  |                           | <1              | <.12         |                 | 3                              | .02             | 1,840        | .12  |
| <i>S. spp.</i>                       |                           |                 |              |                 | 23                             | .13             |              |      |
| Chrysophyceae (yellow - brown algae) |                           |                 |              |                 |                                |                 |              |      |
| <i>Bicoeca</i> spp.                  |                           |                 |              |                 | 9                              | .05             |              |      |
| <i>Dinobryon sertularia</i>          |                           |                 |              |                 | 47                             | .26             |              |      |
| <i>Mallomonas</i> spp.               |                           |                 |              |                 | 3                              | .02             |              |      |
| CRYPTOPHYTA (cryptomonads)           |                           | 54.85           |              | 62.50           |                                | .48             |              | 2.99 |
| Cryptophyceae                        |                           |                 |              |                 |                                |                 |              |      |
| <i>Chroomonas</i> spp.               |                           | 409             | 49.52        | 356             | 9                              | .05             | 1,407        | .09  |
| <i>Cryptomonas</i> spp.              |                           | 44              | 5.33         | 59              | 76                             | .43             | 43,773       | 2.90 |

Table 15.--Taxa and numbers of phytoplankton collected from reservoirs--Continued

|                                     | RESERVOIR 23--BENNET LAKE-- |         |         |        | RESERVOIR 24--EMPIRE RESERVOIR-- |           |        |      |
|-------------------------------------|-----------------------------|---------|---------|--------|----------------------------------|-----------|--------|------|
|                                     | Continued                   |         |         |        | Continued                        |           |        |      |
|                                     | DATE:                       | 5-22-79 | 8-14-79 |        | 5-21-79                          | 8-13-79   |        |      |
|                                     | TIME:                       | 1532    | 1532    |        | 1602                             | 1333      |        |      |
|                                     | DEPTH:                      | 1.0 m   | 1.0 m   |        | 1.0 m                            | 1.5 m     |        |      |
|                                     |                             | Cells   | Per-    | Cells  | Cells                            | Cells     | Per-   | Per- |
|                                     |                             | per mL  | cent    | per mL | per mL                           | per mL    | cent   | cent |
| CYANOPHYTA (blue-green algae)       |                             |         |         | <23.19 | 57.09                            |           | <89.36 |      |
| Cyanophyceae                        |                             |         |         |        |                                  |           |        |      |
| <i>Anabaena Felisii</i>             |                             |         |         |        |                                  | 3,240     | .21    |      |
| <i>A. helicoidea</i>                |                             |         |         |        | 61                               | 29,220    | 1.93   |      |
| <i>A. spiroides</i>                 |                             |         |         |        | 8,910                            | 29,220    | 1.93   |      |
| <i>A. spp.</i>                      |                             |         | <1      | <.15   |                                  |           |        |      |
| <i>Anabaenopsis spp.</i>            |                             |         |         |        |                                  | 12,980    | .86    |      |
| <i>Aphanizomenon flos-aquae</i>     |                             |         |         |        |                                  | 21,650    | 1.43   |      |
| <i>Aphanothece saxicola</i>         |                             |         |         |        |                                  | 32,460    | 2.15   |      |
| <i>Coelosphaerium Kuetzingianum</i> |                             |         |         |        | 1200                             |           |        |      |
| <i>C. spp.</i>                      |                             |         |         |        | 6.74                             |           |        |      |
| <i>Dactylococcopsis spp.</i>        |                             |         | 2       | .30    |                                  |           |        |      |
| <i>Merismopedia tenuissima</i>      |                             |         |         |        |                                  | 121,216   | 8.02   |      |
| <i>Microcystis incerta</i>          |                             |         |         |        |                                  | <1        | <.01   |      |
| <i>Oscillatoria spp.</i>            |                             |         | 150     | 22.59  |                                  | 1,100,640 | 72.80  |      |
| <i>Synechococcus spp.</i>           |                             |         | 1       | .15    |                                  |           |        |      |
| <i>Synechocystis aquatilis</i>      |                             |         |         |        |                                  | 325       | .02    |      |
| EUGLENOPHYTA (euglenoids)           |                             |         |         |        | 4.48                             |           | <.03   |      |
| Euglenophyceae                      |                             |         |         |        |                                  |           |        |      |
| <i>Euglena spp.</i>                 |                             |         |         |        | 35                               | <1        | <.01   |      |
| <i>Phacus spp.</i>                  |                             |         |         |        |                                  | 108       | .01    |      |
| <i>Strombomonas spp.</i>            |                             |         |         |        | 15                               |           |        |      |
| <i>Trachelomonas lefevrei</i>       |                             |         |         |        | 227                              |           |        |      |
| <i>T. spp.</i>                      |                             |         |         |        | 522                              |           |        |      |
| PYRRHOPHYTA (fire algae)            |                             |         |         |        |                                  | 216       | .01    |      |
| Dinophyceae (dinoflagellates)       |                             |         |         |        | <.01                             |           | .05    |      |
| <i>Peridinium spp.</i>              |                             |         |         |        | <1                               | 758       | .05    |      |
| Total number of cells               |                             | 826     |         | 664    | 17,816                           | 1,511,881 |        |      |
| Total number of taxa                |                             | 14      |         | 14     | 41                               | 47        |        |      |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs  
[m<sup>2</sup>, square meter]

| Reservoir:                  | RESERVOIR 1--<br>AIR BASE POND |              |                              |              | RESERVOIR 2--<br>VADOR RESERVOIR |              |                              |              |
|-----------------------------|--------------------------------|--------------|------------------------------|--------------|----------------------------------|--------------|------------------------------|--------------|
|                             | 8-20-78                        |              | 10-2-78                      |              | 8-20-78                          |              | 10-2-78                      |              |
| Date:                       | Number<br>per m <sup>2</sup>   | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup>     | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| ANNELIDA                    |                                |              |                              |              |                                  |              |                              |              |
| HIRUDINEA (leeches)         |                                |              |                              | 1.2          |                                  | 27.2         |                              | 1.5          |
| Pharyngobdellida            |                                |              |                              |              |                                  |              |                              |              |
| <i>Erpobdella punctata</i>  |                                |              | 14                           | .6           |                                  |              |                              |              |
| <i>Nepheleopsis obscura</i> |                                |              | 14                           | .6           | 86                               | 27.2         | 29                           | 1.5          |
| ARTHROPODA                  |                                |              |                              |              |                                  |              |                              |              |
| CRUSTACEA                   |                                |              |                              |              |                                  |              |                              |              |
| Amphipoda (scuds)           |                                | 63.8         |                              | 22.0         |                                  | 4.4          |                              | 16.4         |
| <i>Gammarus</i> sp.         | 29                             | 1.2          |                              |              |                                  |              |                              |              |
| <i>Hyalella azteca</i>      | 1,512                          | 62.6         | 475                          | 22.0         | 14                               | 4.4          | 317                          | 16.4         |
| INSECTA                     |                                |              |                              |              |                                  |              |                              |              |
| Coleoptera (beetles)        |                                | .6           |                              | 4.0          |                                  |              |                              |              |
| <i>Dubiraphia</i> sp.       | 14                             | .6           | 86                           | 4.0          |                                  |              |                              |              |
| Diptera (two-winged flies)  |                                | 19.5         |                              | 69.2         |                                  | 54.8         |                              | 75.0         |
| <i>Chaoborus</i> sp.        | 29                             | 1.2          | 115                          | 5.3          |                                  |              | 14                           | .7           |
| <i>Chironomus</i> sp.       | 317                            | 13.1         | 1,080                        | 50.0         |                                  |              | 1,094                        | 56.6         |
| <i>Coelotanypus</i> sp.     |                                |              | 144                          | 6.7          |                                  |              |                              |              |
| <i>Cricotopus</i> sp.       |                                |              |                              |              |                                  |              | 29                           | 1.5          |
| <i>Cryptochironomus</i> sp. | 14                             | .6           | 29                           | 1.3          | 58                               | 18.4         | 43                           | 2.2          |
| <i>Dicrotendipes</i> sp.    |                                |              | 58                           | 2.7          |                                  |              |                              |              |
| <i>Glyptotendipes</i> sp.   |                                |              |                              |              | 58                               | 18.4         | 43                           | 2.2          |
| <i>Palpomyia</i> sp.        |                                |              | 14                           | .6           |                                  |              | 43                           | 2.2          |
| <i>Paratanytarsus</i> sp.   | 86                             | 3.6          | 14                           | .6           | 43                               | 13.6         | 43                           | 2.2          |
| <i>Polypedilum</i> sp.      |                                |              |                              |              |                                  |              | 144                          | 7.4          |
| <i>Procladius</i> sp.       |                                |              | 43                           | 2.0          | 14                               | 4.4          |                              |              |
| <i>Zavrelimyia</i> sp.      | 29                             | 1.2          |                              |              |                                  |              |                              |              |
| Ephemeroptera (mayflies)    |                                | 1.2          |                              |              |                                  |              |                              | .7           |
| <i>Baetis</i> sp.           | 14                             | .6           |                              |              |                                  |              | 14                           | .7           |
| <i>Caenis</i> sp.           | 14                             | .6           |                              |              |                                  |              |                              |              |
| Hemiptera (true bugs)       |                                |              |                              | 1.3          |                                  |              |                              |              |
| <i>Trichocorixa</i> sp.     |                                |              | 29                           | 1.3          |                                  |              |                              |              |
| Odonata (dragonflies)       |                                | .6           |                              |              |                                  |              |                              |              |
| <i>Ischnura</i> sp.         | 14                             | .6           |                              |              |                                  |              |                              |              |
| Trichoptera (caddis flies)  |                                | 1.2          |                              | 2.0          |                                  | 4.4          |                              | 1.5          |
| <i>Molanna</i> sp.          | 14                             | .6           | 43                           | 2.0          | 14                               | 4.4          | 29                           | 1.5          |
| <i>Phryganea</i> sp.        | 14                             | .6           |                              |              |                                  |              |                              |              |
| MOLLUSCA                    |                                |              |                              |              |                                  |              |                              |              |
| GASTROPODA (snails)         |                                | 12.5         |                              |              |                                  |              |                              | 1.5          |
| Basommatophora              |                                |              |                              |              |                                  |              |                              |              |
| <i>Gyraulus</i> sp.         | 245                            | 10.1         |                              |              |                                  |              |                              |              |
| <i>Physa</i> sp.            | 58                             | 2.4          |                              |              |                                  |              | 29                           | 1.5          |
| BIVALVIA (bivalves)         |                                | .6           |                              |              |                                  | 9.2          |                              | 3.7          |
| Nuculoidea                  |                                |              |                              |              |                                  |              |                              |              |
| <i>Musculium</i> sp.        | 14                             | .6           |                              |              |                                  |              |                              |              |
| <i>Pisidium</i> sp.         |                                |              |                              |              |                                  |              | 72                           | 3.7          |
| <i>Sphaerium</i> sp.        |                                |              |                              |              | 29                               | 9.2          |                              |              |
| Total number of organisms   | 2,417                          |              | 2,158                        |              | 316                              |              | 1,933                        |              |
| Total number of taxa        | 16                             |              | 14                           |              | 8                                |              | 14                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:<br>Date:              | RESERVOIR 3--VR-82           |              |                              |              | RESERVOIR 4--VR-77           |              |                              |              |
|----------------------------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|
|                                  | 8-21-78                      |              | 10-4-78                      |              | 8-21-78                      |              | 10-4-78                      |              |
|                                  | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| ANNELIDA                         |                              |              |                              |              |                              |              |                              |              |
| HIRUDINEA (leeches)              |                              |              |                              |              |                              | 1.4          |                              | 6.3          |
| Rhynchobdellida                  |                              |              |                              |              |                              |              |                              |              |
| <i>Helobdella stagnalis</i>      |                              |              |                              |              |                              |              | 29                           | 1.6          |
| Pharyngobdellida                 |                              |              |                              |              |                              |              |                              |              |
| <i>Dina fervida</i>              |                              |              |                              |              |                              |              | 14                           | .8           |
| <i>Nepheleopsis obscura</i>      |                              |              |                              |              | 29                           | 1.4          | 72                           | 3.9          |
| OLIGOCHAETA (aquatic earthworms) |                              |              |                              | 17.5         |                              |              |                              |              |
| Plesiopora                       |                              |              |                              |              |                              |              |                              |              |
| <i>Limnodrilus</i> sp.           |                              |              | 58                           | 17.5         |                              |              |                              |              |
| ARTHROPODA                       |                              |              |                              |              |                              |              |                              |              |
| CRUSTACEA                        |                              |              |                              |              |                              |              |                              |              |
| Amphipoda (scuds)                |                              | 13.3         |                              | 39.3         |                              |              |                              | 12.4         |
| <i>Hyalella azteca</i>           | 130                          | 13.3         | 130                          | 39.3         |                              |              | 230                          | 12.4         |
| Conchostraca (clam shrimps)      |                              |              |                              |              |                              |              |                              | 2.3          |
| <i>Caenestheriella setosa</i>    |                              |              |                              |              |                              |              | 43                           | 2.3          |
| INSECTA                          |                              |              |                              |              |                              |              |                              |              |
| Diptera (two-winged flies)       |                              | 70.6         |                              | 34.7         |                              | 73.7         |                              | 25.7         |
| <i>Arcto-Conchapelopia</i> sp.   | 29                           | 3.0          |                              |              |                              |              |                              |              |
| <i>Chironomus</i> sp.            | 576                          | 58.8         |                              |              | 1,339                        | 64.6         | 317                          | 17.1         |
| <i>Corynoneura</i> sp.           | 29                           | 3.0          |                              |              |                              |              |                              |              |
| <i>Cricotopus</i> sp.            |                              |              |                              |              | 43                           | 2.1          | 14                           | .8           |
| <i>Cryptochironomus</i> sp.      | 14                           | 1.4          |                              |              |                              |              |                              |              |
| <i>Glyptotendipes</i> sp.        | 29                           | 3.0          | 115                          | 34.7         |                              |              |                              |              |
| <i>Polypedilum</i> sp.           |                              |              |                              |              |                              |              | 14                           | .8           |
| <i>Procladius</i> sp.            |                              |              |                              |              | 101                          | 4.9          | 115                          | 6.2          |
| <i>Psectrotanypus</i> sp.        |                              |              |                              |              | 43                           | 2.1          | 14                           | .8           |
| <i>Zavrelimyia</i> sp.           | 14                           | 1.4          |                              |              |                              |              |                              |              |
| Ephemeroptera (mayflies)         |                              | 5.9          |                              |              |                              | 20.8         |                              | 32.6         |
| <i>Caenis</i> sp.                |                              |              |                              |              |                              |              |                              |              |
| <i>Callibaetis</i> sp.           | 58                           | 5.9          |                              |              | 432                          | 20.8         | 605                          | 32.6         |
| Odonata (dragonflies)            |                              |              |                              | 4.2          |                              | 3.5          |                              | 3.9          |
| <i>Ischnura</i> sp.              |                              |              | 14                           | 4.2          | 72                           | 3.5          | 72                           | 3.9          |
| Trichoptera (caddis flies)       |                              | 1.4          |                              |              |                              | .7           |                              | .8           |
| <i>Agraylea</i> sp.              |                              |              |                              |              | 14                           | .7           |                              |              |
| <i>Molanna</i> sp.               | 14                           | 1.4          |                              |              |                              |              | 14                           | .8           |
| MOLLUSCA                         |                              |              |                              |              |                              |              |                              |              |
| GASTROPODA (snails)              |                              |              |                              | 4.2          |                              |              |                              | 16.3         |
| Basommatophora                   |                              |              |                              |              |                              |              |                              |              |
| <i>Gyraulus</i> sp.              |                              |              |                              |              |                              |              | 144                          | 7.8          |
| <i>Helisoma</i> sp.              |                              |              |                              |              |                              |              | 43                           | 2.3          |
| <i>Lymnaea</i> sp.               |                              |              |                              |              |                              |              | 115                          | 6.2          |
| <i>Physa</i> sp.                 |                              |              | 14                           | 4.2          |                              |              |                              |              |
| BIVALVIA (bivalves)              |                              | 8.8          |                              |              |                              |              |                              |              |
| Nuculoidea                       |                              |              |                              |              |                              |              |                              |              |
| <i>Musculium</i> sp.             | 86                           | 8.8          |                              |              |                              |              |                              |              |
| Total number of organisms        | 979                          |              | 331                          |              | 2,073                        |              | 1,855                        |              |
| Total number of taxa             | 10                           |              | 5                            |              | 8                            |              | 16                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:                     | RESERVOIR 5--<br>THOENY RESERVOIR |              |                              |              | RESERVOIR 6--<br>ICH PAIR RESERVOIR |              |                              |              |
|--------------------------------|-----------------------------------|--------------|------------------------------|--------------|-------------------------------------|--------------|------------------------------|--------------|
|                                | 8-22-78                           |              | 10-3-78                      |              | 8-22-78                             |              | 10-3-78                      |              |
| Date:                          | Number<br>per m <sup>2</sup>      | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup>        | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| <b>ANNELIDA</b>                |                                   |              |                              |              |                                     |              |                              |              |
| HIRUDINEA (leeches)            |                                   | 50.0         |                              | 33.3         |                                     | 8.3          |                              | 1.5          |
| Rhynchobdellida                |                                   |              |                              |              |                                     |              |                              |              |
| <i>Helobdella stagnalis</i>    |                                   |              |                              |              | 288                                 | 6.2          |                              |              |
| Pharyngobdellida               |                                   |              |                              |              |                                     |              |                              |              |
| <i>Dina fervida</i>            |                                   |              |                              |              | 14                                  | .3           | 29                           | .5           |
| <i>Erpobdella punctata</i>     | 14                                | 50.0         |                              |              | 43                                  | .9           |                              |              |
| <i>Nepheleopsis obscura</i>    |                                   |              | 14                           | 33.3         | 43                                  | .9           | 58                           | 1.0          |
| <b>ARTHROPODA</b>              |                                   |              |                              |              |                                     |              |                              |              |
| <b>CRUSTACEA</b>               |                                   |              |                              |              |                                     |              |                              |              |
| Amphipoda (scuds)              |                                   |              |                              | 33.3         |                                     | 44.0         |                              | 10.7         |
| <i>Gammarus</i> sp.            |                                   |              |                              |              |                                     |              | 29                           | .5           |
| <i>Hyalella azteca</i>         |                                   |              | 14                           | 33.3         | 2,044                               | 44.0         | 576                          | 10.2         |
| <b>INSECTA</b>                 |                                   |              |                              |              |                                     |              |                              |              |
| Coleoptera (beetles)           |                                   |              |                              |              |                                     | 16.4         |                              | 1.6          |
| <i>Brychius</i> sp.            |                                   |              |                              |              | 158                                 | 3.4          |                              |              |
| <i>Dubiraphia</i> sp.          |                                   |              |                              |              |                                     |              | 43                           | .8           |
| <i>Haliphus</i> spp.           |                                   |              |                              |              | 547                                 | 11.8         | 43                           | .8           |
| <i>Hydroporus</i> sp.          |                                   |              |                              |              | 58                                  | 1.2          |                              |              |
| Diptera (two-winged flies)     |                                   |              |                              |              |                                     | 20.9         |                              | 56.3         |
| <i>Arcto-Conchapelopia</i> sp. |                                   |              |                              |              | 72                                  | 1.5          | 86                           | 1.5          |
| <i>Chaoborus</i> sp.           |                                   |              |                              |              |                                     |              | 14                           | .2           |
| <i>Chironomus</i> sp.          |                                   |              |                              |              | 562                                 | 12.1         | 2,433                        | 43.1         |
| <i>Corynoneura</i> sp.         |                                   |              |                              |              | 14                                  | .3           |                              |              |
| <i>Cricotopus</i> sp.          |                                   |              |                              |              | 216                                 | 4.6          |                              |              |
| <i>Einfeldia</i> sp.           |                                   |              |                              |              | 14                                  | .3           |                              |              |
| <i>Ephydra</i> sp.             |                                   |              |                              |              | 29                                  | .6           |                              |              |
| <i>Eukiefferiella</i> sp.      |                                   |              |                              |              | 14                                  | .3           |                              |              |
| <i>Glyptotendipes</i> sp.      |                                   |              |                              |              | 14                                  | .3           | 432                          | 7.7          |
| <i>Metriocnemus</i> sp.        |                                   |              |                              |              |                                     |              | 130                          | 2.3          |
| <i>Palpomyia</i> sp.           |                                   |              |                              |              | 43                                  | .9           |                              |              |
| <i>Procladius</i> sp.          |                                   |              |                              |              |                                     |              | 86                           | 1.5          |
| Ephemeroptera (mayflies)       |                                   |              |                              |              |                                     | 2.2          |                              | 11.4         |
| <i>Baetis</i> sp.              |                                   |              | 14                           | 33.3         |                                     |              |                              |              |
| <i>Caenis</i> sp.              |                                   |              |                              |              |                                     |              | 14                           | .2           |
| <i>Callibaetis</i> sp.         |                                   |              |                              |              | 101                                 | 2.2          | 634                          | 11.2         |
| Odonata (dragonflies)          |                                   | 50.0         |                              |              |                                     | 2.8          |                              | 6.1          |
| <i>Anax junia</i> sp.          |                                   |              |                              |              | 29                                  | .6           |                              |              |
| <i>Ischnura</i> sp.            | 14                                | 50.0         |                              |              | 101                                 | 2.2          | 346                          | 6.1          |
| Trichoptera (caddis flies)     |                                   |              |                              |              |                                     | .3           |                              | .2           |
| <i>Agraylea</i> sp.            |                                   |              |                              |              | 14                                  | .3           |                              |              |
| <i>Phryganea</i> sp.           |                                   |              |                              |              |                                     |              | 14                           | .2           |
| <b>MOLLUSCA</b>                |                                   |              |                              |              |                                     |              |                              |              |
| GASTROPODA (snails)            |                                   |              |                              |              |                                     | 4.9          |                              | 12.0         |
| Basommatophora                 |                                   |              |                              |              |                                     |              |                              |              |
| <i>Gyraulus</i> sp.            |                                   |              |                              |              |                                     |              | 173                          | 3.1          |
| <i>Physa</i> sp.               |                                   |              |                              |              | 230                                 | 4.9          | 504                          | 8.9          |
| Total number of organisms      | 28                                |              | 42                           |              | 4,643                               |              | 5,644                        |              |
| Total number of taxa           | 2                                 |              | 3                            |              | 22                                  |              | 18                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:                     | RESERVOIR 7--<br>NEAR JOHN ARNOLD RANCH |              |                              |              | RESERVOIR 8--<br>NEAR EAST FORK WILLOW CREEK |              |                              |              |
|--------------------------------|---|--------------|------------------------------|--------------|--|--------------|------------------------------|--------------|
|                                | 8-22-78                                 |              | 10-3-78                      |              | 8-24-78                                      |              | 10-3-78                      |              |
| Date:                          | Number<br>per m <sup>2</sup>            | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup>                 | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| ANNELIDA                       |   |              |                              |              |  |              |                              |              |
| HIRUDINEA (leeches)            |   | 1.6          |                              | 0.3          |  | 9.8          |                              | 12.6         |
| Rhynchobdellida                |   |              |                              |              |  |              |                              |              |
| <i>Glossiphonia complanata</i> | 58                                      | 1.3          |                              |              | 14   | .4           |                              |              |
| <i>Helobdella stagnalis</i>    |   |              |                              |              | 29   | .9           |                              |              |
| Pharyngobdellida               |   |              |                              |              |  |              |                              |              |
| <i>Dina fervida</i>            | 14                                      | .3           |                              |              |  |              |                              |              |
| <i>Nepheleopsis obscura</i>    |   |              | 14                           | .3           | 274  | 8.5          | 274                          | 12.6         |
| ARTHROPODA                     |   |              |                              |              |  |              |                              |              |
| CRUSTACEA                      |   |              |                              |              |  |              |                              |              |
| Amphipoda (scuds)              |   | 58.2         |                              | 69.1         |  | 32.0         |                              | 48.4         |
| <i>Gammarus</i> sp.            | 259                                     | 5.8          | 259                          | 6.0          | 14   | .4           |                              |              |
| <i>Hyalella azteca</i>         | 2,347                                   | 52.4         | 2,722                        | 63.1         | 1,022  | 31.6         | 1,051                        | 48.4         |
| INSECTA                        |   |              |                              |              |  |              |                              |              |
| Coleoptera (beetles)           |   | .6           |                              | .9           |  | 1.3          |                              | .6           |
| <i>Bidessus</i> sp.            |   |              | 14                           | .3           |  |              |                              |              |
| <i>Brachyvatus</i> sp.         | 14                                      | .3           |                              |              |  |              |                              |              |
| <i>Brychius</i> sp.            |   |              |                              |              | 43   | 1.3          |                              |              |
| <i>Dubiraphia</i> sp.          |   |              |                              |              |  |              | 14                           | .6           |
| <i>Haliphus</i> spp.           |   |              | 14                           | .3           |  |              |                              |              |
| <i>Hygrotus</i> sp.            | 14                                      | .3           |                              |              |  |              |                              |              |
| <i>Laccodytes</i> sp.          |   |              | 14                           | .3           |  |              |                              |              |
| Diptera (two-winged flies)     |   | 30.9         |                              | 6.9          |  | 30.7         |                              | 31.7         |
| <i>Chaoborus</i> sp.           | 43                                      | 1.0          | 14                           | .3           | 86   | 2.7          |                              |              |
| <i>Chironomus</i> sp.          | 317                                     | 7.1          |                              |              | 202  | 6.2          | 14                           | .6           |
| <i>Cricotopus</i> sp.          |   |              |                              |              | 14   | .4           |                              |              |
| <i>Cryptotendipes</i> sp.      |   |              |                              |              | 29   | .9           |                              |              |
| <i>Dicrotendipes</i> sp.       |   |              | 43                           | 1.0          |  |              |                              |              |
| <i>Einfeldia</i> sp.           | 14                                      | .3           |                              |              |  |              |                              |              |
| <i>Glyptotendipes</i> sp.      | 58                                      | 1.3          | 14                           | .3           |  |              |                              |              |
| <i>Metriocnemus</i> sp.        | 14                                      | .3           |                              |              |  |              |                              |              |
| <i>Palpomyia</i> sp.           |   |              |                              |              |  |              | 490                          | 22.5         |
| <i>Polypedilum</i> sp.         |   |              |                              |              | 158  | 4.9          |                              |              |
| <i>Procladius</i> sp.          | 936                                     | 20.9         | 230                          | 5.3          | 504  | 15.6         | 187                          | 8.6          |
| Ephemeroptera (mayflies)       |   | 2.3          |                              | 3.7          |  | 2.2          |                              | .6           |
| <i>Baetis</i> sp.              | 58                                      | 1.3          | 43                           | 1.0          |  |              | 14                           | .6           |
| <i>Callibaetis</i> sp.         | 43                                      | 1.0          | 115                          | 2.7          | 72   | 2.2          |                              |              |
| Hemiptera (true bugs)          |   |              |                              | .3           |  | .4           |                              | 4.0          |
| <i>Cenocorixa</i> sp.          |   |              | 14                           | .3           |  |              |                              |              |
| <i>Cymatia americana</i>       |   |              |                              |              | 14   | .4           |                              |              |
| <i>Pseudocorixa</i> sp.        |   |              |                              |              |  |              | 86                           | 4.0          |
| Odonata (dragonflies)          |   | 5.8          |                              | 8.0          |  | 5.3          |                              | .6           |
| <i>Ischnura</i> sp.            | 259                                     | 5.8          | 346                          | 8.0          | 173  | 5.3          | 14                           | .6           |
| MOLLUSCA                       |   |              |                              |              |  |              |                              |              |
| GASTROPODA (snails)            |   | .6           |                              | 10.7         |  | 18.2         |                              | 1.3          |
| Basommatophora                 |   |              |                              |              |  |              |                              |              |
| <i>Gyraulus</i> sp.            | 29                                      | .6           | 346                          | 8.0          |  |              |                              |              |
| <i>Helisoma</i> sp.            |   |              |                              |              | 230  | 7.1          |                              |              |
| <i>Physa</i> sp.               |   |              | 115                          | 2.7          | 360  | 11.1         | 29                           | 1.3          |
| Total number of organisms      | 4,477                                   |              | 4,317                        |              | 3,238  |              | 2,173                        |              |
| Total number of taxa           | 16                                      |              | 16                           |              | 17   |              | 10                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:<br>Date:            | RESERVOIR 9--GAY             |              | RESERVOIR                    |              | RESERVOIR 10--VR-64          |              |                              |              |
|--------------------------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|
|                                | 8-23-78                      |              | 10-5-78                      |              | 8-23-78                      |              | 10-5-78                      |              |
|                                | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| <b>ANNELIDA</b>                |                              |              |                              |              |                              |              |                              |              |
| HIRUDINEA (leeches)            |                              |              |                              |              |                              | 4.1          |                              | 3.5          |
| Rhynchobdellida                |                              |              |                              |              |                              |              |                              |              |
| <i>Glossiphonia complanata</i> |                              |              |                              |              |                              |              | 29                           | .7           |
| <i>Helobdella stagnalis</i>    |                              |              |                              |              |                              |              | 14                           | .3           |
| Pharyngobdellida               |                              |              |                              |              |                              |              |                              |              |
| <i>Nepheleopsis obscura</i>    |                              |              |                              |              | 115                          | 4.1          | 101                          | 2.5          |
| <b>ARTHROPODA</b>              |                              |              |                              |              |                              |              |                              |              |
| <b>CRUSTACEA</b>               |                              |              |                              |              |                              |              |                              |              |
| Amphipoda (scuds)              |                              | 5.5          |                              | 4.2          |                              | 51.9         |                              | 75.0         |
| <i>Gammarus</i> sp.            |                              |              |                              |              |                              |              | 14                           | .3           |
| <i>Hyalella azteca</i>         | 86                           | 5.5          | 158                          | 4.2          | 1,440                        | 51.9         | 3,053                        | 74.7         |
| <b>INSECTA</b>                 |                              |              |                              |              |                              |              |                              |              |
| Coleoptera (beetles)           |                              | 6.4          |                              |              |                              |              |                              | .7           |
| <i>Dubiraphia</i> sp.          | 86                           | 5.5          |                              |              |                              |              |                              |              |
| <i>Haliphus</i> spp.           | 14                           | .9           |                              |              |                              |              | 29                           | .7           |
| Diptera (two-winged flies)     |                              | 63.1         |                              | 72.0         |                              | 39.9         |                              | 15.4         |
| <i>Chaoborus</i> sp.           |                              |              |                              |              | 72                           | 2.6          | 86                           | 2.1          |
| <i>Chironomus</i> sp.          | 533                          | 34.3         | 101                          | 2.7          |                              |              |                              |              |
| <i>Cladotanytarsus</i> sp.     |                              |              | 14                           | .4           |                              |              |                              |              |
| <i>Cryptochironomus</i> sp.    | 130                          | 8.4          |                              |              | 14                           | .5           | 14                           | .3           |
| <i>Eukiefferiella</i> sp.      |                              |              | 14                           | .4           |                              |              |                              |              |
| <i>Glyptotendipes</i> sp.      |                              |              | 274                          | 7.3          |                              |              |                              |              |
| <i>Metriocnemus</i> sp.        |                              |              | 850                          | 22.7         |                              |              |                              |              |
| <i>Orthocladus</i> sp.         |                              |              |                              |              | 14                           | .5           |                              |              |
| <i>Palpomyia</i> sp.           | 115                          | 7.4          | 14                           | .4           |                              |              |                              |              |
| <i>Paratanytarsus</i> sp.      |                              |              | 994                          | 26.6         | 14                           | .5           |                              |              |
| <i>Polypedilum</i> sp.         | 29                           | 1.9          |                              |              | 86                           | 3.1          | 29                           | .7           |
| <i>Procladius</i> sp.          | 158                          | 10.2         | 432                          | 11.5         | 907                          | 32.7         | 504                          | 12.3         |
| <i>Tanytus</i> sp.             | 14                           | .9           |                              |              |                              |              |                              |              |
| Ephemeroptera (mayflies)       |                              | 1.9          |                              | 6.9          |                              |              |                              | 2.5          |
| <i>Baetis</i> sp.              |                              |              |                              |              |                              |              | 72                           | 1.8          |
| <i>Caenis</i> sp.              | 29                           | 1.9          | 259                          | 6.9          |                              |              |                              |              |
| <i>Callibaetis</i> sp.         |                              |              |                              |              |                              |              | 29                           | .7           |
| Hemiptera (true bugs)          |                              |              |                              | 2.3          |                              |              |                              |              |
| <i>Hesperocorixa</i> sp.       |                              |              | 86                           | 2.3          |                              |              |                              |              |
| Odonata (dragonflies)          |                              | 10.2         |                              | 7.7          |                              | 4.1          |                              | 2.1          |
| <i>Ischnura</i> sp.            | 158                          | 10.2         | 288                          | 7.7          | 115                          | 4.1          | 86                           | 2.1          |
| Trichoptera (caddis flies)     |                              | .9           |                              | 2.7          |                              |              |                              | .3           |
| <i>Nectopsyche</i> sp.         | 14                           | .9           | 86                           | 2.3          |                              |              |                              |              |
| <i>Phryganea</i> sp.           |                              |              | 14                           | .4           |                              |              | 14                           | .3           |
| <b>MOLLUSCA</b>                |                              |              |                              |              |                              |              |                              |              |
| GASTROPODA (snails)            |                              | 12.0         |                              | 3.1          |                              |              |                              | .3           |
| Basommatophora                 |                              |              |                              |              |                              |              |                              |              |
| <i>Gyraulus</i> sp.            |                              |              | 115                          | 3.1          |                              |              |                              |              |
| <i>Physa</i> sp.               | 187                          | 12.0         |                              |              |                              |              | 14                           | .3           |
| BIVALVIA (bivalves)            |                              |              |                              | 1.1          |                              |              |                              |              |
| Nuculoidea                     |                              |              |                              |              |                              |              |                              |              |
| <i>Pisidium</i> sp.            |                              |              | 43                           | 1.1          |                              |              |                              |              |
| Total number of organisms      | 1,553                        |              | 3,742                        |              | 2,777                        |              | 4,088                        |              |
| Total number of taxa           | 13                           |              | 16                           |              | 9                            |              | 15                           |              |



Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:                     | RESERVOIR 11--<br>HOSE RESERVOIR |              |                              |              | RESERVOIR 12--NEAR<br>HINSDALE LIVESTOCK COMPANY |              |                              |              |
|--------------------------------|----------------------------------|--------------|------------------------------|--------------|--|--------------|------------------------------|--------------|
|                                | 8-24-78                          |              | 10-5-78                      |              | 8-23-78  |              | 10-5-78                      |              |
| Date:                          | Number<br>per m <sup>2</sup>     | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup>                     | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| <b>ANNELIDA</b>                |                                  |              |                              |              |  |              |                              |              |
| HIRUDINEA (leeches)            |                                  | 5.6          |                              | 0.2          |  | 2.8          |                              | 4.4          |
| Rhynchobdellida                |                                  |              |                              |              |  |              |                              |              |
| <i>Glossiphonia complanata</i> |                                  |              |                              |              |  |              | 29                           | .9           |
| <i>Helobdella stagnalis</i>    | 14                               | 1.4          |                              |              |  |              | 14                           | .4           |
| Pharyngobdellida               |                                  |              |                              |              |  |              |                              |              |
| <i>Nepheleopsis obscura</i>    | 43                               | 4.2          | 14                           | .2           | 86   | 2.8          | 101                          | 3.1          |
| <b>ARTHROPODA</b>              |                                  |              |                              |              |  |              |                              |              |
| <b>CRUSTACEA</b>               |                                  |              |                              |              |  |              |                              |              |
| Amphipoda (scuds)              |                                  | 14.1         |                              | 1.8          |  | 6.9          |                              | 60.3         |
| <i>Hyalella azteca</i>         | 144                              | 14.1         | 144                          | 1.8          | 216  | 6.9          | 1,987                        | 60.3         |
| <b>INSECTA</b>                 |                                  |              |                              |              |  |              |                              |              |
| Coleoptera (beetles)           |                                  |              |                              |              |  | .4           |                              | 2.6          |
| <i>Halipus</i> spp.            |                                  |              |                              |              | 14   | .4           | 86                           | 2.6          |
| Diptera (two-winged flies)     |                                  | 77.6         |                              | 95.0         |  | 81.3         |                              | 26.2         |
| <i>Chaoborus</i> sp.           | 72                               | 7.1          | 288                          | 3.6          | 130  | 4.2          | 158                          | 4.8          |
| <i>Chironomus</i> sp.          | 101                              | 9.9          | 749                          | 9.3          | 403  | 12.9         |                              |              |
| <i>Chrysops</i> sp.            | 14                               | 1.4          |                              |              |  |              |                              |              |
| <i>Cricotopus</i> sp.          | 29                               | 2.8          |                              |              |  |              |                              |              |
| <i>Cryptochironomus</i> sp.    |                                  |              |                              |              | 14   | .4           |                              |              |
| <i>Cryptotendipes</i> sp.      |                                  |              |                              |              | 28   | .9           |                              |              |
| <i>Dicrotendipes</i> sp.       |                                  |              | 216                          | 2.7          |  |              |                              |              |
| <i>Eukiefferiella</i> sp.      |                                  |              |                              |              | 58   | 1.9          |                              |              |
| <i>Glyptotendipes</i> sp.      |                                  |              |                              |              |  |              | 43                           | 1.3          |
| <i>Metriocnemus</i> sp.        |                                  |              | 677                          | 8.4          |  |              |                              |              |
| <i>Palpomyia</i> sp.           | 86                               | 8.4          | 14                           | .2           | 58   | 1.9          | 43                           | 1.3          |
| <i>Paratanytarsus</i> sp.      | 144                              | 14.1         | 5,299                        | 65.8         | 86   | 2.8          |                              |              |
| <i>Polypedilum</i> sp.         | 101                              | 9.9          | 29                           | .4           | 86   | 2.8          |                              |              |
| <i>Procladius</i> sp.          | 245                              | 24.0         | 374                          | 4.6          | 1,642  | 52.6         | 619                          | 18.8         |
| <i>Tanytarsus</i> sp.          |                                  |              |                              |              | 28   | .9           |                              |              |
| Ephemeroptera (mayflies)       |                                  | 1.4          |                              | .8           |  | 3.2          |                              | 6.6          |
| <i>Caenis</i> sp.              |                                  |              | 29                           | .4           |  |              | 29                           | .9           |
| <i>Callibaetis</i> sp.         | 14                               | 1.4          | 29                           | .4           | 101  | 3.2          | 187                          | 5.7          |
| Odonata (dragonflies)          |                                  | 1.4          |                              | 2.0          |  | .4           |                              |              |
| <i>Ischnura</i> sp.            | 14                               | 1.4          | 158                          | 2.0          | 14   | .4           |                              |              |
| Trichoptera (caddis flies)     |                                  |              |                              | .4           |  | 1.8          |                              |              |
| <i>Molanna</i> sp.             |                                  |              | 14                           | .2           | 43   | 1.4          |                              |              |
| <i>Phryganea</i> sp.           |                                  |              | 14                           | .2           | 14   | .4           |                              |              |
| <b>MOLLUSCA</b>                |                                  |              |                              |              |  |              |                              |              |
| GASTROPODA (snails)            |                                  |              |                              |              |  | 1.4          |                              |              |
| Basommatophora                 |                                  |              |                              |              |  |              |                              |              |
| <i>Physa</i> sp.               |                                  |              |                              |              | 43   | 1.4          |                              |              |
| BIVALVIA (bivalves)            |                                  |              |                              |              |  | 1.8          |                              |              |
| Nuculoidea                     |                                  |              |                              |              |  |              |                              |              |
| <i>Pisidium</i> sp.            |                                  |              |                              |              | 28   | .9           |                              |              |
| <i>Sphaerium</i> sp.           |                                  |              |                              |              | 28   | .9           |                              |              |
| Total number of organisms      | 1,021                            |              | 8,048                        |              | 3,120  |              | 3,296                        |              |
| Total number of taxa           | 13                               |              | 15                           |              | 20   |              | 11                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:                          | RESERVOIR 13--<br>SHARP RESERVOIR |              |                              |              | RESERVOIR 14--<br>PR-22      |              |                              |              |
|-------------------------------------|-----------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|
|                                     | 5-23-79                           |              | 8-15-79                      |              | 5-23-79                      |              | 8-15-79                      |              |
| Date:                               | Number<br>per m <sup>2</sup>      | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| ANNELIDA                            |                                   |              |                              |              |                              |              |                              |              |
| HIRUDINEA (leeches)                 |                                   | 1.0          |                              | 3.3          |                              | 2.1          |                              | 2.6          |
| Rhynchobdellida                     |                                   |              |                              |              |                              |              |                              |              |
| <i>Glossiphonia complanata</i>      |                                   |              |                              |              |                              |              | 29                           | .7           |
| <i>Helobdella stagnalis</i>         | 29                                | .7           | 144                          | 1.5          | 29                           | 1.4          |                              |              |
| Pharyngobdellida                    |                                   |              |                              |              |                              |              |                              |              |
| <i>Dina fervida</i>                 |                                   |              |                              |              |                              |              | 14                           | .4           |
| <i>Nepheleopsis obscura</i>         | 14                                | .3           | 173                          | 1.8          | 14                           | .7           | 58                           | 1.5          |
| OLIGOCHAETA (aquatic<br>earthworms) |                                   | 17.1         |                              | 12.8         |                              | 29.5         |                              | 10.9         |
| Plesiopora                          |                                   |              |                              |              |                              |              |                              |              |
| <i>Aulordrilus</i> sp.              | 14                                | .3           | 58                           | .6           |                              |              |                              |              |
| <i>Limnodrilus</i> sp.              | 29                                | .7           | 14                           | .1           | 29                           | 1.4          | 43                           | 1.1          |
| <i>Pelosclex</i> sp.                | 691                               | 16.1         | 1,152                        | 12.1         | 562                          | 28.1         | 389                          | 9.8          |
| ARTHROPODA                          |                                   |              |                              |              |                              |              |                              |              |
| ARACHNIDA                           |                                   |              |                              |              |                              |              |                              |              |
| Acarina (water mites)               |                                   |              | 29                           | .3           |                              |              |                              |              |
| CRUSTACEA                           |                                   |              |                              |              |                              |              |                              |              |
| Amphipoda (scuds)                   |                                   | 12.4         |                              | 21.6         |                              | 18.0         |                              | 38.0         |
| <i>Gammarus</i> sp.                 |                                   |              | 360                          | 3.8          | 72                           | 3.6          | 922                          | 23.2         |
| <i>Hyalella azteca</i>              | 533                               | 12.4         | 1,699                        | 17.8         | 288                          | 14.4         | 590                          | 14.8         |
| INSECTA                             |                                   |              |                              |              |                              |              |                              |              |
| Coleoptera (beetles)                |                                   |              |                              |              |                              |              |                              | .4           |
| <i>Halipus</i> spp.                 |                                   |              |                              |              |                              |              | 14                           | .4           |
| Diptera (two-winged flies)          |                                   | 64.9         |                              | 41.5         |                              | 45.9         |                              | 43.3         |
| <i>Chaoborus</i> sp.                | 1,195                             | 27.8         | 1,512                        | 15.8         | 115                          | 5.7          | 130                          | 3.3          |
| <i>Chironomus</i> sp.               | 72                                | 1.7          | 288                          | 3.0          | 216                          | 10.8         | 691                          | 17.4         |
| <i>Chrysops</i> sp.                 | 14                                | .3           | 14                           | .1           |                              |              | 43                           | 1.1          |
| <i>Cladopelma</i> sp.               | 490                               | 11.4         |                              |              |                              |              | 14                           | .4           |
| <i>Cricotopus</i> sp.               | 29                                | .7           | 1,814                        | 19.0         | 14                           | .7           | 86                           | 2.2          |
| <i>Cryptochironomus</i> sp.         |                                   |              | 14                           | .1           |                              |              |                              |              |
| <i>Dicrotendipes</i> sp.            |                                   |              | 29                           | .3           |                              |              |                              |              |
| <i>Einfeldia</i> sp.                |                                   |              | 14                           | .1           | 29                           | 1.4          | 58                           | 1.5          |
| <i>Eukiefferiella</i> sp.           |                                   |              | 14                           | .1           |                              |              | 14                           | .4           |
| <i>Parachironomus</i> sp.           | 173                               | 4.0          |                              |              |                              |              |                              |              |
| <i>Paratanytarsus</i> sp.           | 14                                | .3           | 29                           | .3           |                              |              | 101                          | 2.5          |
| <i>Polypedilum</i> sp.              | 14                                | .3           |                              |              |                              |              |                              |              |
| <i>Procladius</i> sp.               | 763                               | 17.7         | 245                          | 2.6          | 547                          | 27.3         | 562                          | 14.1         |
| <i>Psectrocladius</i> sp.           | 29                                | .7           |                              |              |                              |              |                              |              |
| <i>Psectrotanytus</i> sp.           |                                   |              | 14                           | .1           |                              |              |                              |              |
| <i>Tanytarsus</i> sp.               |                                   |              |                              |              |                              |              | 14                           | .4           |
| Ephemeroptera (mayflies)            |                                   | 1.0          |                              | 4.5          |                              |              |                              | 1.5          |
| <i>Baetis</i> sp.                   |                                   |              | 14                           | .1           |                              |              |                              |              |
| <i>Caenis</i> sp.                   | 43                                | 1.0          |                              |              |                              |              | 58                           | 1.5          |
| <i>Callibaetis</i> sp.              |                                   |              | 418                          | 4.4          |                              |              |                              |              |
| Hemiptera (true bugs)               |                                   | .3           |                              | .4           |                              |              |                              |              |
| <i>Hesperocorixa</i> sp.            | 14                                | .3           | 29                           | .3           |                              |              |                              |              |
| <i>Notonecta</i> sp.                |                                   |              | 14                           | .1           |                              |              |                              |              |
| Odonata (dragonflies)               |                                   | 1.3          |                              | 13.6         |                              | 3.6          |                              | 2.9          |
| <i>Coenagrion</i> sp.               |                                   |              | 72                           | .8           | 14                           | .7           | 29                           | .7           |
| <i>Ischnura</i> sp.                 | 58                                | 1.3          | 1,195                        | 12.5         | 58                           | 2.9          | 86                           | 2.2          |
| <i>Leucorrhinia</i> sp.             |                                   |              | 29                           | .3           |                              |              |                              |              |
| MOLLUSCA                            |                                   |              |                              |              |                              |              |                              |              |
| GASTROPODA (snails)                 |                                   | 1.3          |                              | .8           |                              | .7           |                              | .7           |
| Basommatophora                      |                                   |              |                              |              |                              |              |                              |              |
| <i>Physa</i> sp.                    | 58                                | 1.3          | 72                           | .8           | 14                           | .7           | 29                           | .7           |
| BIVALVIA (bivalves)                 |                                   | .7           |                              | 1.0          |                              |              |                              |              |
| Nuculoidea                          |                                   |              |                              |              |                              |              |                              |              |
| <i>Musculium</i> sp.                |                                   |              | 14                           | .1           |                              |              |                              |              |
| <i>Pisidium</i> sp.                 | 29                                | .7           | 86                           | .9           |                              |              |                              |              |
| Total number of organisms           | 4,305                             |              | 9,559                        |              | 2,001                        |              | 3,974                        |              |
| Total number of taxa                | 21                                |              | 29                           |              | 14                           |              | 22                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:<br>Date:              | RESERVOIR 15--<br>ALTERNATE RESERVOIR |              |                              |              | RESERVOIR 16--<br>WHITEWATER LAKE (NORTH) |              |                              |              |
|----------------------------------|---------------------------------------|--------------|------------------------------|--------------|---|--------------|------------------------------|--------------|
|                                  | 5-23-79                               |              | 8-15-79                      |              | 5-24-79                                   |              | 8-16-79                      |              |
|                                  | Number<br>per m <sup>2</sup>          | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup>              | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| <b>ANNELIDA</b>                  |                                       |              |                              |              |   |              |                              |              |
| HIRUDINEA (leeches)              |                                       | 15.9         |                              | 3.0          |   |              |                              |              |
| Rhynchobdellida                  |                                       |              |                              |              |   |              |                              |              |
| <i>Glossiphonia complanata</i>   | 86                                    | 4.3          |                              |              |   |              |                              |              |
| <i>Helobdella stagnalis</i>      | 173                                   | 8.7          | 43                           | 1.0          |   |              |                              |              |
| Pharyngobdellida                 |                                       |              |                              |              |   |              |                              |              |
| <i>Nephelopsis obscura</i>       | 58                                    | 2.9          | 86                           | 2.0          |   |              |                              |              |
| OLIGOCHAETA (aquatic earthworms) |                                       | 2.9          |                              | 1.0          |   | 23.0         |                              | 2.6          |
| Plesiopora                       |                                       |              |                              |              |   |              |                              |              |
| <i>Limnodrilus</i> sp.           |                                       |              |                              |              | 288                                       | 23.0         |                              |              |
| <i>Pelosclex</i> sp.             | 58                                    | 2.9          | 43                           | 1.0          |   |              | 29                           | 2.6          |
| <b>ARTHROPODA</b>                |                                       |              |                              |              |   |              |                              |              |
| ARACHNIDA                        |                                       |              |                              |              |   |              |                              |              |
| Acarina (water mites)            | 29                                    | 1.5          | 86                           | 2.0          |   |              |                              |              |
| CRUSTACEA                        |                                       |              |                              |              |   |              |                              |              |
| Amphipoda (scuds)                |                                       | 31.1         |                              | 45.3         |   |              |                              |              |
| <i>Hyalella azteca</i>           | 619                                   | 31.1         | 1,987                        | 45.3         |   |              |                              |              |
| INSECTA                          |                                       |              |                              |              |   |              |                              |              |
| Coleoptera (beetles)             |                                       |              |                              | .3           |   |              |                              |              |
| <i>Laccophilus</i> sp.           |                                       |              | 14                           | .3           |   |              |                              |              |
| Diptera (two-winged flies)       |                                       | 38.4         |                              | 17.3         |   | 75.8         |                              | 97.4         |
| <i>Ablabesmyia</i> sp.           | 245                                   | 12.3         |                              |              |   |              |                              |              |
| <i>Ceratopogonidae</i> sp.       | 29                                    | 1.5          |                              |              | 878                                       | 70.2         | 187                          | 16.7         |
| <i>Chaoborus</i> sp.             | 43                                    | 2.2          | 58                           | 1.3          |   |              |                              |              |
| <i>Chironomus</i> sp.            | 29                                    | 1.5          | 403                          | 9.2          | 43  | 3.4          | 29                           | 2.6          |
| <i>Cladopelma</i> sp.            |                                       |              | 29                           | .7           |   |              | 101                          | 9.0          |
| <i>Cricotopus</i> sp.            | 130                                   | 6.5          | 14                           | .3           | 14  | 1.1          | 317                          | 28.2         |
| <i>Cryptochironomus</i> sp.      |                                       |              |                              |              |   |              | 115                          | 10.2         |
| <i>Cryptotendipes</i> sp.        |                                       |              |                              |              |   |              | 43                           | 3.8          |
| <i>Dicrotendipes</i> sp.         | 58                                    | 2.9          |                              |              |   |              |                              |              |
| <i>Einfeldia</i> sp.             |                                       |              | 72                           | 1.6          |   |              | 14                           | 1.2          |
| <i>Paratanytarsus</i> sp.        | 72                                    | 3.6          | 14                           | .3           |   |              | 101                          | 9.0          |
| <i>Procladius</i> sp.            | 158                                   | 7.9          | 173                          | 3.9          |   |              |                              |              |
| <i>Rheotanytarsus</i> sp.        |                                       |              |                              |              |   |              | 29                           | 2.6          |
| <i>Tanytus</i> sp.               |                                       |              |                              |              | 14  | 1.1          | 158                          | 14.1         |
| Ephemeroptera (mayflies)         |                                       | 1.5          |                              | 28.5         |   |              |                              |              |
| <i>Caenis</i> sp.                | 29                                    | 1.5          |                              |              |   |              |                              |              |
| <i>Callibaetis</i> sp.           |                                       |              | 1,253                        | 28.5         |   |              |                              |              |
| Hemiptera (true bugs)            |                                       |              |                              | .3           |   | 1.1          |                              |              |
| <i>Hesperocorixa</i> sp.         |                                       |              | 14                           | .3           | 14  | 1.1          |                              |              |
| Odonata (dragonflies)            |                                       | 5.1          |                              | 1.3          |   |              |                              |              |
| <i>Coenagrion</i> sp.            | 58                                    | 2.9          |                              |              |   |              |                              |              |
| <i>Ischnura</i> sp.              | 43                                    | 2.2          | 58                           | 1.3          |   |              |                              |              |
| Trichoptera (caddis flies)       |                                       | .7           |                              |              |   |              |                              |              |
| <i>Mystacides</i> sp.            | 14                                    | .7           |                              |              |   |              |                              |              |
| <b>MOLLUSCA</b>                  |                                       |              |                              |              |   |              |                              |              |
| GASTROPODA (snails)              |                                       | 2.2          |                              | 1.0          |   |              |                              |              |
| Basommatophora                   |                                       |              |                              |              |   |              |                              |              |
| <i>Gyraulus</i> sp.              |                                       |              | 14                           | .3           |   |              |                              |              |
| <i>Physa</i> sp.                 | 43                                    | 2.2          | 29                           | .7           |   |              |                              |              |
| BIVALVIA (bivalves)              |                                       | .7           |                              |              |   |              |                              |              |
| Nuculoidea                       |                                       |              |                              |              |   |              |                              |              |
| <i>Pisidium</i> sp.              | 14                                    | .7           |                              |              |   |              |                              |              |
| Total number of organisms        | 1,988                                 |              | 4,390                        |              | 1,251                                     |              | 1,123                        |              |
| Total number of taxa             | 20                                    |              | 18                           |              | 6   |              | 11                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:                       | RESERVOIR 17--<br>WHITEWATER LAKE (SOUTH) |              |                              |              | RESERVOIR 18--<br>COOL PIT RESERVOIR |              |                              |              |
|----------------------------------|---|--------------|------------------------------|--------------|--------------------------------------|--------------|------------------------------|--------------|
|                                  | 5-24-79                                   |              | 8-16-79                      |              | 5-24-79                              |              | 8-15-79                      |              |
| Date:.                           | Number<br>per m <sup>2</sup>              | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup>         | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| ANNELIDA                         |   |              |                              |              |                                      |              |                              |              |
| OLIGOCHAETA (aquatic earthworms) |   | 4.3          |                              | 0.3          |                                      | 21.7         |                              |              |
| Plesiopora                       |   |              |                              |              |                                      |              |                              |              |
| <i>Limnodrilus</i> sp.           | 43  | 4.3          | 14                           | .3           | 187                                  | 21.7         |                              |              |
| ARTHROPODA                       |   |              |                              |              |                                      |              |                              |              |
| CRUSTACEA                        |   |              |                              |              |                                      |              |                              |              |
| Amphipoda (scuds)                |   |              |                              | 1.2          |                                      | 3.4          |                              | 8.3          |
| <i>Hyalella azte a</i>           |   |              | 58                           | 1.2          | 29                                   | 3.4          | 259                          | 8.3          |
| INSECTA                          |   |              |                              |              |                                      |              |                              |              |
| Coleoptera (beetles)             |   | 4.3          |                              | 1.2          |                                      |              |                              | .8           |
| <i>Deronectes</i> sp.            |   |              | 43                           | .9           |                                      |              |                              |              |
| <i>Haliphus</i> spp.             | 43  | 4.3          |                              |              |                                      |              | 14                           | .4           |
| <i>Laccophilus</i> sp.           |   |              |                              |              |                                      |              | 14                           | .4           |
| <i>Rhantus</i> sp.               |   |              | 14                           | .3           |                                      |              |                              |              |
| Diptera (two-winged flies)       |   | 79.6         |                              | 94.4         |                                      | 74.9         |                              | 77.5         |
| <i>Ablabesmyia</i> sp.           |   |              | 29                           | .6           |                                      |              |                              |              |
| <i>Ceratopogonidae</i> sp.       | 130                                       | 13.1         | 216                          | 4.5          | 101                                  | 11.7         |                              |              |
| <i>Chaoborus</i> sp.             |   |              |                              |              | 72                                   | 8.3          | 2,419                        | 77.1         |
| <i>Chironomus</i> sp.            | 14  | 1.4          |                              |              | 115                                  | 13.3         | 14                           | .4           |
| <i>Cricotopus</i> sp.            | 461                                       | 46.5         | 446                          | 9.4          |                                      |              |                              |              |
| <i>Cryptochironomus</i> sp.      | 14  | 1.4          | 187                          | 3.9          |                                      |              |                              |              |
| <i>Cryptotendipes</i> sp.        |   |              | 2,275                        | 47.9         |                                      |              |                              |              |
| <i>Einfeldia</i> sp.             | 43  | 4.3          |                              |              |                                      |              |                              |              |
| <i>Parachironomus</i> sp.        | 58  | 5.8          |                              |              | 14                                   | 1.6          |                              |              |
| <i>Parametriocenumus</i> sp.     | 43  | 4.3          | 230                          | 4.8          |                                      |              |                              |              |
| <i>Polypedilum</i> sp.           | 14  | 1.4          |                              |              | 14                                   | 1.6          |                              |              |
| <i>Procladius</i> sp.            |   |              | 590                          | 12.4         | 331                                  | 38.4         |                              |              |
| <i>Psectrocladius</i> sp.        |   |              | 288                          | 6.1          |                                      |              |                              |              |
| <i>Tanypus</i> sp.               |   |              | 130                          | 2.7          |                                      |              |                              |              |
| <i>Thienemannimyia</i> sp.       | 14  | 1.4          | 101                          | 2.1          |                                      |              |                              |              |
| Ephemeroptera (mayflies)         |   |              |                              | 2.4          |                                      |              |                              | 5.5          |
| <i>Caenis</i> sp.                |   |              |                              |              |                                      |              | 29                           | .9           |
| <i>Callibaetis</i> sp.           |   |              | 115                          | 2.4          |                                      |              | 144                          | 4.6          |
| Hemiptera (true bugs)            |   |              |                              | .3           |                                      |              |                              |              |
| <i>Hesperocorixa</i> sp.         |   |              | 14                           | .3           |                                      |              |                              |              |
| Odonata (dragonflies)            |   | 10.2         |                              |              |                                      |              |                              | 7.3          |
| <i>Ischnura</i> sp.              | 101                                       | 10.2         |                              |              |                                      |              | 230                          | 7.3          |
| Trichoptera (caddis flies)       |   | 1.4          |                              |              |                                      |              |                              | .4           |
| <i>Phryganea</i> sp.             |   |              |                              |              |                                      |              | 14                           | .4           |
| <i>Triaenodes</i> sp.            | 14  | 1.4          |                              |              |                                      |              |                              |              |
| Total number of organisms        | 992                                       |              | 4,750                        |              | 863                                  |              | 3,137                        |              |
| Total number of taxa             | 13  |              | 16                           |              | 8                                    |              | 9                            |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

|                                     | Reservoir: |     | RESERVOIR 19--KING RESERVOIR |              |                              |              | RESERVOIR 20--PR-18          |              |                              |              |
|-------------------------------------|------------|-----|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|
|                                     | Date:      |     | 5-22-79                      |              | 8-14-79                      |              | 5-22-79                      |              | 8-14-79                      |              |
|                                     |            |     | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| <b>ANNELIDA</b>                     |            |     |                              |              |                              |              |                              |              |                              |              |
| HIRUDINEA (leeches)                 |            |     |                              | 3.3          |                              | 2.6          |                              | 13.6         |                              | 9.2          |
| Rhynchobdellida                     |            |     |                              |              |                              |              |                              |              |                              |              |
| <i>Glossiphonia complanata</i>      |            | 14  | 1.1                          |              | 43                           | 1.3          | 14                           | 1.7          | 14                           | .6           |
| <i>Helobdella stagnalis</i>         |            | 14  | 1.1                          |              |                              |              | 14                           | 1.7          | 72                           | 3.3          |
| Pharyngobdellida                    |            |     |                              |              |                              |              |                              |              |                              |              |
| <i>Erpobdella punctata</i>          |            |     |                              |              |                              |              | 43                           | 5.1          |                              |              |
| <i>Nepheleopsis obscura</i>         |            | 14  | 1.1                          |              | 43                           | 1.3          | 43                           | 5.1          | 115                          | 5.3          |
| OLIGOCHAETA (aquatic<br>earthworms) |            |     |                              | 2.2          |                              | 2.2          |                              | 1.7          |                              | 2.0          |
| Plesiopora                          |            |     |                              |              |                              |              |                              |              |                              |              |
| <i>Limnodrilus</i> sp.              |            | 29  | 2.2                          |              | 72                           | 2.2          | 14                           | 1.7          | 43                           | 2.0          |
| <b>ARTHROPODA</b>                   |            |     |                              |              |                              |              |                              |              |                              |              |
| ARACHNIDA                           |            |     |                              |              |                              |              |                              |              |                              |              |
| Acarina (water mites)               |            | 14  | 1.1                          |              |                              |              |                              |              |                              |              |
| CRUSTACEA                           |            |     |                              |              |                              |              |                              |              |                              |              |
| Amphipoda (scuds)                   |            |     | 16.7                         |              |                              | 24.4         |                              | 46.0         |                              | 37.1         |
| <i>Gammarus</i> sp.                 |            |     |                              |              | 144                          | 4.4          | 29                           | 3.4          |                              |              |
| <i>Hyalella azteca</i>              |            | 216 | 16.7                         |              | 648                          | 20.0         | 360                          | 42.6         | 806                          | 37.1         |
| INSECTA                             |            |     |                              |              |                              |              |                              |              |                              |              |
| Coleoptera (beetles)                |            |     | 1.1                          |              |                              | .9           |                              |              |                              | 3.3          |
| <i>Dubiraphia</i> sp.               |            |     |                              |              |                              |              |                              |              | 58                           | 2.7          |
| <i>Halipus</i> spp.                 |            | 14  | 1.1                          |              | 29                           | .9           |                              |              | 14                           | .6           |
| Diptera (two-winged flies)          |            |     | 66.8                         |              |                              | 50.1         |                              | 29.1         |                              | 8.4          |
| <i>Ablabesmyia</i> sp.              |            | 14  | 1.1                          |              |                              |              |                              |              |                              |              |
| <i>Arcto-Conchapelopia</i> sp.      |            |     |                              |              |                              |              |                              |              |                              |              |
| <i>Ceratopogonidae</i> sp.          |            | 29  | 2.2                          |              |                              |              | 58                           | 6.9          |                              |              |
| <i>Chaoborus</i> sp.                |            |     |                              |              |                              |              |                              |              |                              |              |
| <i>Chironomus</i> sp.               |            | 72  | 5.6                          |              | 144                          | 4.4          | 14                           | 1.7          | 86                           | 4.0          |
| <i>Cladopelma</i> sp.               |            |     |                              |              |                              |              | 43                           | 5.1          |                              |              |
| <i>Cricotopus</i> sp.               |            |     |                              |              | 14                           | .4           |                              |              | 14                           | .6           |
| <i>Cryptochironomus</i> sp.         |            | 288 | 22.3                         |              |                              |              | 29                           | 3.4          |                              |              |
| <i>Endochironomus</i> sp.           |            | 187 | 14.5                         |              | 1,411                        | 43.6         | 14                           | 1.7          | 14                           | .6           |
| <i>Glyptotendipes</i> sp.           |            | 29  | 2.2                          |              | 14                           | .4           | 14                           | 1.7          |                              |              |
| <i>Paratanytarsus</i> sp.           |            | 14  | 1.1                          |              | 43                           | 1.3          | 14                           | 1.7          | 14                           | .6           |
| <i>Procladius</i> sp.               |            | 230 | 17.8                         |              |                              |              | 58                           | 6.9          | 29                           | 1.3          |
| <i>Psectrocladius</i> sp.           |            |     |                              |              |                              |              | 14                           | 1.7          | 29                           | 1.3          |
| Ephemeroptera (mayflies)            |            |     | 8.9                          |              |                              | 4.8          |                              | 3.4          |                              | 14.0         |
| <i>Caenis</i> sp.                   |            | 86  | 6.7                          |              | 14                           | .4           | 14                           | 1.7          | 130                          | 6.0          |
| <i>Callibaetis</i> sp.              |            | 29  | 2.2                          |              | 144                          | 4.4          | 14                           | 1.7          | 173                          | 8.0          |
| Hemiptera (true bugs)               |            |     |                              |              |                              |              |                              |              |                              | 3.3          |
| <i>Hesperocorixa</i> sp.            |            |     |                              |              |                              |              |                              |              | 72                           | 3.3          |
| Odonata (dragonflies)               |            |     |                              |              |                              | 10.7         |                              | 5.1          |                              | 15.9         |
| <i>Aeshna</i> sp.                   |            |     |                              |              |                              |              |                              |              | 29                           | 1.3          |
| <i>Ischnura</i> sp.                 |            |     |                              |              | 346                          | 10.7         | 43                           | 5.1          | 317                          | 14.6         |
| Trichoptera (caddis flies)          |            |     |                              |              |                              | 1.3          |                              |              |                              | 6.0          |
| <i>Molanna</i> sp.                  |            |     |                              |              |                              |              |                              |              | 43                           | 2.0          |
| <i>Mystacides</i> sp.               |            |     |                              |              |                              |              |                              |              | 29                           | 1.3          |
| <i>Phryganea</i> sp.                |            |     |                              |              | 43                           | 1.3          |                              |              | 58                           | 2.7          |
| <b>MOLLUSCA</b>                     |            |     |                              |              |                              |              |                              |              |                              |              |
| GASTROPODA (snails)                 |            |     |                              |              |                              | 2.6          |                              | 1.7          |                              |              |
| Basommatophora                      |            |     |                              |              |                              |              |                              |              |                              |              |
| <i>Gyraulus</i> sp.                 |            |     |                              |              | 14                           | .4           |                              |              |                              |              |
| <i>Helisoma</i> sp.                 |            |     |                              |              |                              |              | 14                           | 1.7          |                              |              |
| <i>Physa</i> sp.                    |            |     |                              |              | 72                           | 2.2          |                              |              |                              |              |
| BIVALVIA (bivalves)                 |            |     |                              |              |                              |              |                              |              |                              | .6           |
| Nuculoidea                          |            |     |                              |              |                              |              |                              |              |                              |              |
| <i>Pisidium</i> sp.                 |            |     |                              |              |                              |              |                              |              | 14                           | .6           |
| Total number of organisms           |            |     | 1,293                        |              | 3,238                        |              | 846                          |              | 2,173                        |              |
| Total number of taxa                |            |     | 17                           |              | 17                           |              | 19                           |              | 22                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:<br>Date:                 | RESERVOIR 21--PARROT FLATS   |              |                              |              | RESERVOIR 22--PR-71          |              |                              |              |
|-------------------------------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|
|                                     | 5-21-79                      |              | 8-13-79                      |              | 5-21-79                      |              | 8-13-79                      |              |
|                                     | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| ANNELIDA                            |                              |              |                              |              |                              |              |                              |              |
| HIRUDINEA (leeches)                 |                              |              |                              |              |                              | 8.1          |                              | 2.6          |
| Rhynchobdellida                     |                              |              |                              |              |                              |              |                              |              |
| <i>Glossiphonia complanata</i>      |                              |              |                              |              |                              |              | 72                           | .9           |
| Pharyngobdellida                    |                              |              |                              |              |                              |              |                              |              |
| <i>Erpobdella punctata</i>          |                              |              |                              |              |                              |              | 43                           | .6           |
| <i>Nepheleopsis obscura</i>         |                              |              |                              |              | 101                          | 8.1          | 86                           | 1.1          |
| OLIGOCHAETA (aquatic<br>earthworms) |                              | 100          |                              | 98.8         |                              | 5.7          |                              | .8           |
| Plesiopora                          |                              |              |                              |              |                              |              |                              |              |
| <i>Limnodrilus</i> sp.              | 259                          | 100          | 1,109                        | 98.8         | 72                           | 5.7          | 43                           | .6           |
| <i>Pelosclex</i> sp.                |                              |              |                              |              |                              |              | 14                           | .2           |
| ARTHROPODA                          |                              |              |                              |              |                              |              |                              |              |
| ARACHNIDA                           |                              |              |                              |              |                              |              |                              |              |
| Acarina (water mites)               |                              |              |                              |              |                              |              | 29                           | .4           |
| CRUSTACEA                           |                              |              |                              |              |                              |              |                              |              |
| Amphipoda (scuds)                   |                              |              |                              |              |                              | 28.8         |                              | 39.5         |
| <i>Gammarus</i> sp.                 |                              |              |                              |              | 130                          | 10.4         | 115                          | 1.5          |
| <i>Hyalella azteca</i>              |                              |              |                              |              | 230                          | 18.4         | 2,880                        | 38.0         |
| INSECTA                             |                              |              |                              |              |                              |              |                              |              |
| Coleoptera (beetles)                |                              |              |                              |              |                              |              |                              |              |
| <i>Deronectes</i> sp.               |                              |              | 14                           | 1.2          |                              |              |                              | .8           |
| <i>Halipus</i> spp.                 |                              |              |                              |              |                              |              | 58                           | .8           |
| Diptera (two-winged flies)          |                              |              |                              |              |                              | 50.6         |                              | 39.8         |
| <i>Ablabesmyia</i> sp.              |                              |              |                              |              |                              |              | 72                           | .9           |
| <i>Ceratopogonidae</i> sp.          |                              |              |                              |              |                              |              | 14                           | .2           |
| <i>Chaoborus</i> sp.                |                              |              |                              |              | 202                          | 16.1         | 374                          | 4.9          |
| <i>Chironomus</i> sp.               |                              |              |                              |              | 101                          | 8.1          | 158                          | 2.1          |
| <i>Chrysops</i> sp.                 |                              |              |                              |              | 14                           | 1.1          |                              |              |
| <i>Cladopelma</i> sp.               |                              |              |                              |              | 14                           | 1.1          |                              |              |
| <i>Corynoneura</i> sp.              |                              |              |                              |              |                              |              | 14                           | .2           |
| <i>Cricotopus</i> sp.               |                              |              |                              |              | 29                           | 2.3          | 374                          | 4.9          |
| <i>Endochironomus</i> sp.           |                              |              |                              |              |                              |              | 187                          | 2.5          |
| <i>Paratanytarsus</i> sp.           |                              |              |                              |              |                              |              | 1,498                        | 19.7         |
| <i>Polypedilum</i> sp.              |                              |              |                              |              |                              |              | 202                          | 2.7          |
| <i>Procladius</i> sp.               |                              |              |                              |              | 173                          | 13.8         | 14                           | .2           |
| <i>Psectrocladius</i> sp.           |                              |              |                              |              | 101                          | 8.1          |                              |              |
| <i>Psectrotanypus</i> sp.           |                              |              |                              |              |                              |              | 115                          | 1.5          |
| Ephemeroptera (mayflies)            |                              |              |                              |              |                              | 1.1          |                              | 11.0         |
| <i>Caenis</i> sp.                   |                              |              |                              |              | 14                           | 1.1          | 187                          | 2.5          |
| <i>Callibaetis</i> sp.              |                              |              |                              |              |                              |              | 648                          | 8.5          |
| Hemiptera (true bugs)               |                              |              |                              |              |                              |              |                              | 2.1          |
| <i>Hesperocorixa</i> sp.            |                              |              |                              |              |                              |              | 158                          | 2.1          |
| Odonata (dragonflies)               |                              |              |                              |              |                              | 5.7          |                              | 2.5          |
| <i>Coenagrion</i> sp.               |                              |              |                              |              | 14                           | 1.1          |                              |              |
| <i>Ischnura</i> sp.                 |                              |              |                              |              | 58                           | 4.6          | 187                          | 2.5          |
| Trichoptera (caddis flies)          |                              |              |                              |              |                              |              |                              | .2           |
| <i>Phryganea</i> sp.                |                              |              |                              |              |                              |              | 14                           | .2           |
| MOLLUSCA                            |                              |              |                              |              |                              |              |                              |              |
| GASTROPODA (snails)                 |                              |              |                              |              |                              |              |                              |              |
| Basommatophora                      |                              |              |                              |              |                              |              |                              | .4           |
| <i>Physa</i> sp.                    |                              |              |                              |              |                              |              | 29                           | .4           |
| <hr/>                               |                              |              |                              |              |                              |              |                              |              |
| Total number of organisms           | 259                          |              | 1,123                        |              | 1,253                        |              | 7,585                        |              |
| Total number of taxa                | 1                            |              | 2                            |              | 14                           |              | 26                           |              |

Table 16.--Taxa and numbers of benthic invertebrates collected from reservoirs--Continued

| Reservoir:<br>Date:                 | RESERVOIR 23--BENNET LAKE    |              |                              |              | RESERVOIR 24--EMPIRE RESERVOIR |              |                              |              |
|-------------------------------------|------------------------------|--------------|------------------------------|--------------|--------------------------------|--------------|------------------------------|--------------|
|                                     | 5-22-79                      |              | 8-14-79                      |              | 5-21-79                        |              | 8-13-79                      |              |
|                                     | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent | Number<br>per m <sup>2</sup>   | Per-<br>cent | Number<br>per m <sup>2</sup> | Per-<br>cent |
| <b>ANNELIDA</b>                     |                              |              |                              |              |                                |              |                              |              |
| HIRUDINEA (leeches)                 |                              |              |                              | 2.4          |                                |              |                              | 1.6          |
| Rhynchobdellida                     |                              |              |                              |              |                                |              |                              |              |
| <i>Glossiphonia complanata</i>      |                              |              | 14                           | .8           |                                |              | 14                           | .5           |
| Pharyngobdellida                    |                              |              |                              |              |                                |              |                              |              |
| <i>Dina fervida</i>                 |                              |              | 14                           | .8           |                                |              |                              |              |
| <i>Nephelopsis obscura</i>          |                              |              | 14                           | .8           |                                |              | 29                           | 1.1          |
| OLIGOCHAETA (aquatic<br>earthworms) |                              |              |                              | .8           |                                | 23.8         |                              | 38.1         |
| Plesiopora                          |                              |              |                              |              |                                |              |                              |              |
| <i>Limnodrilus</i> sp.              |                              |              | 14                           | .8           | 130                            | 23.8         | 994                          | 38.1         |
| <b>ARTHROPODA</b>                   |                              |              |                              |              |                                |              |                              |              |
| <b>CRUSTACEA</b>                    |                              |              |                              |              |                                |              |                              |              |
| Amphipoda (scuds)                   |                              |              |                              |              |                                | 34.2         |                              | 11.1         |
| <i>Hyalella azteca</i>              |                              |              |                              |              | 187                            | 34.2         | 288                          | 11.1         |
| <b>INSECTA</b>                      |                              |              |                              |              |                                |              |                              |              |
| Coleoptera (beetles)                |                              |              |                              | 1.6          |                                |              |                              |              |
| <i>Haliphus</i> spp.                |                              |              | 14                           | .8           |                                |              |                              |              |
| <i>Hygrotus</i> sp.                 |                              |              | 14                           | .8           |                                |              |                              |              |
| Diptera (two-winged flies)          |                              | 83.5         |                              | 66.6         |                                | 29.0         |                              | 41.4         |
| <i>Ceratopogonidae</i> sp.          | 29                           | 1.9          |                              |              |                                |              | 29                           | 1.1          |
| <i>Chaoborus</i> sp.                | 86                           | 5.8          | 43                           | 2.4          | 29                             | 5.3          |                              |              |
| <i>Chironomus</i> sp.               | 346                          | 23.2         | 43                           | 2.4          | 14                             | 2.6          | 302                          | 11.6         |
| <i>Cladopelma</i> sp.               | 14                           | .9           | 14                           | .8           | 14                             | 2.6          |                              |              |
| <i>Cricotopus</i> sp.               | 187                          | 12.5         | 259                          | 14.4         | 29                             | 5.3          | 29                           | 1.1          |
| <i>Dicrotendipes</i> sp.            | 14                           | .9           |                              |              |                                |              | 58                           | 2.2          |
| <i>Einfeldia</i> sp.                | 374                          | 25.0         | 115                          | 6.4          |                                |              | 43                           | 1.7          |
| <i>Glyptotendipes</i> sp.           | 115                          | 7.7          | 29                           | 1.6          |                                |              | 605                          | 23.2         |
| <i>Paratanytarsus</i> sp.           | 14                           | .9           |                              |              |                                |              |                              |              |
| <i>Procladius</i> sp.               | 43                           | 2.9          | 274                          | 15.3         | 72                             | 13.2         | 14                           | .5           |
| <i>Psectrocladius</i> sp.           |                              |              | 389                          | 21.7         |                                |              |                              |              |
| <i>Psectrotanytus</i> sp.           | 14                           | .9           |                              |              |                                |              |                              |              |
| <i>Thienemannimyia</i> sp.          | 14                           | .9           | 29                           | 1.6          |                                |              |                              |              |
| Ephemeroptera (mayflies)            |                              |              |                              | 5.6          |                                | 7.9          |                              | 1.1          |
| <i>Caenis</i> sp.                   |                              |              |                              |              | 43                             | 7.9          | 29                           | 1.1          |
| <i>Callibaetis</i> sp.              |                              |              | 101                          | 5.6          |                                |              |                              |              |
| Hemiptera (true bugs)               |                              | 4.8          |                              | .8           |                                |              |                              | 1.7          |
| <i>Hesperocorixa</i> sp.            | 72                           | 4.8          | 14                           | .8           |                                |              | 43                           | 1.7          |
| Odonata (dragonflies)               |                              | 8.7          |                              | 8.0          |                                | 2.6          |                              |              |
| <i>Coenagrion</i> sp.               |                              |              |                              |              | 14                             | 2.6          |                              |              |
| <i>Ischnura</i> sp.                 | 130                          | 8.7          | 144                          | 8.0          |                                |              |                              |              |
| Trichoptera (caddis flies)          |                              |              |                              | .8           |                                |              |                              |              |
| <i>Phryganea</i> sp.                |                              |              | 14                           | .8           |                                |              |                              |              |
| <b>MOLLUSCA</b>                     |                              |              |                              |              |                                |              |                              |              |
| GASTROPODA (snails)                 |                              | 2.7          |                              | 13.6         |                                |              |                              | .5           |
| Basommatophora                      |                              |              |                              |              |                                |              |                              |              |
| <i>Gyraulus</i> sp.                 |                              |              | 14                           | .8           |                                |              |                              |              |
| <i>Helisoma</i> sp.                 | 14                           | .9           |                              |              |                                |              |                              |              |
| <i>Lymnaea</i> sp.                  | 14                           | .9           |                              |              |                                |              |                              |              |
| <i>Physa</i> sp.                    | 14                           | .9           | 230                          | 12.8         |                                |              | 14                           | .5           |
| BIVALVIA (bivalves)                 |                              |              |                              |              |                                | 2.6          |                              | 4.4          |
| Nuculoidea                          |                              |              |                              |              |                                |              |                              |              |
| <i>Pisidium</i> sp.                 |                              |              |                              |              | 14                             | 2.6          | 115                          | 4.4          |
| <hr/>                               |                              |              |                              |              |                                |              |                              |              |
| Total number of organisms           | 1,494                        |              | 1,796                        |              | 546                            |              | 2,606                        |              |
| Total number of taxa                | 17                           |              | 21                           |              | 10                             |              | 15                           |              |